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Contact Info

Journal of Education in Science, Environment and Health (JESEH)
Email: jesehoffice@gmail.com
Web : www.jeseh.net

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Enhancing Science Learning through Science Trade Book Reading for 5th Graders

Ching-San Lai, Kuei-Lin Chan

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Abstract

This study explores the learning outcome of science learning with integrating science trade book reading of 5th graders. A quasi-experimental design was used in this study at an elementary school in New Taipei City. Students in the experimental group (N=59) were given instructional strategies on integrating science trade book reading into science learning, while the control group (N=59) received traditional instruction. Three science trade books were used in science reading strategies for the experimental group. Two research instruments were used in this study were a science achievement test (30 items, KR_{21}=.80), and an attitudes toward science scale (31 items, *Cronbach* α=.94). The results were processed by *ANCOVA* analysis, finding that students in the experimental group got higher scores than students in the control group (F= 4.921, p < .05). Although there was no significant difference between the two groups in the outcome of the attitudes toward science scale, feedback from students in the experimental group showed that they enjoyed and benefited from integrating science trade book reading into science learning and hoped can they could continue to learn more science by integrating science trade book reading. Thus integrating science trade book reading into science learning was beneficial for the 5th graders in this study.

Introduction

Lai (2012) pointed out that although science textbooks for elementary schools are filled with new and novel science experiments, inquiry activities that encourage students to explore the historical facts of natural sciences are limited. This makes it students less inclined to study scientific concepts and perform scientific experiments, or even worse, feeling averse to science learning (Lai, 2012). Therefore, finding effective ways to solve these problems caused by science textbooks, and strengthening students' interest in scientific inquiry are important topics for science educators.

The concept of using outside materials to enhance science is not new, introducing science units with a favorite read-aloud of a science trade book can be an effective way to engage students and to improve their reading skills, teach content, and connect learning to the real world and students' own interests (Adams & Phillips, 2016; DeVore-Wedding, 2016; Ford, Brickhouse, Lottero-Perdue, & Kittleson, 2006; Gee, 2004; Gulley, Thomas, Wulbur, & McMurry, 2014; Guthrie, Wigfield, & Von Seeker, 2000; Hapgood & Palinscar, 2007; Jagger & Yore, 2012; Marzano, Pickering, & Pollock, 2001; Mayberry, 2014; National Science Teachers Association, 2002). Mayberry (2014) noted that the Next Generation Science Standards and the Common Core State Standards in Language Arts encourage the use of content integration and promote the efficient use of classroom time.

In addition, the National Science Teachers Association (2015) states that science teachers and mentors continue to be challenged to meet the high expectations of the Framework for K-12 Science Education and the Next Generation Science Standards. To develop curricula that meet these challenges, literature is an essential partner. Ford, Brickhouse, Lottero-Perdue, and Kittleson (2006) indicated that informational science texts provide numerous ways for teachers to address both literacy and science standards, while supporting children's learning, engagement, and interest. Moreover, background knowledge and vocabulary are key components in a literacy-rich science curriculum, and are also important in providing the means to improve student understanding and achievement in science (Fazio & Gallagher, 2014; Fisher, Grant, & Frey, 2009; Gallagher, Fazio, & Ciampa, 2017; Gallagher, Fazio, & Gunning, 2012; Marzano, 2004; Romance & Vitale, 2012a). Recently, much attention has been given to reading activities in Taiwan, leading many primary and secondary school science teachers to integrate science history, science reading materials, and/or science reading and writing strategies into science teaching. Lai and Wang (2016) found that incorporating these measures into science teaching did improve students' science learning performance. Therefore, this study is trying to explore the learning outcome of integrating science trade book reading into the science learning of 5th graders.

Literature Review

Science Trade Book Reading

Reading science trade books is a convenient way for students to build literacy skills while learning science content (National Science Teachers Association, 2015). Curriculum materials are an important tool to help teachers engage students in scientific inquiry (Davis & Krajcik, 2005). Adams and Phillips (2016) pointed out that using trade books in the science classroom can promote authentic science practices and comprehension of scientific concepts. According to Lai (2006), "science reading" involves the use of science reading materials, including science trade books, science articles, scientific fairy tales, science stories, and science picture books. It is hoped that the inclusion of these reading resources in science teaching will help students gain a fuller understanding of scientific topics, and will enhance their science learning effectiveness.

Ross and Frey (2002) stated that science trade books can interpret a single science concept in a deeper perspective. Further, science trade books enable students with different levels of reading abilities to choose science trade books that are appropriate to them. Science trade books are more interesting and easier to understand than science textbooks. Butzow and Butzow (2000) further pointed out that narratives in the form of stories in science trade books are more effective in stimulating students' interest than scientific facts as commonly presented in textbooks. In addition, the colored pictures and charts included in science trade books are more effective than wordy descriptions of abstract concepts often included in textbooks. Mantzicopoulos and Patrick (2011) emphasized that frequent reading of science trade books can help children engage science learning and develop an interest in it. Royce (2016) noted that elementary-age children need opportunities to think about and develop an idea from its inception through to its conclusion in order to expand their thinking and engage in scientific processes. Generating and expanding on ideas allows children to consider problems or questions they would want to solve through experimentation, and it requires perseverance and practice.

Huang and Hsu (2003) studies children's books with topics on the history of science and found that: (1) students are highly interested in the history of science when presented in a children's book; (2) reading children's books about the history of science enables students to acquire more knowledge about scientists, and provides an opportunity for them to recognize the achievements of women scientists; (3) these books allow students to learn about the developmental process of science in addition to scientific concepts; and (4) studying the history of science can provide students with an opportunity to understand the nature of science.

Moreover, previous research on the integration of science reading into science teaching has revealed that: (1) reading about the history of science can enhance students' understanding of scientific concepts and their thinking ability (Chiu & Koa, 2006; Guthrie, Wigfield, & Von Seeker, 2000; Guzzetti & Bang, 2011; Guzzetti & Mardis, 2017; Lai, 2008, 2012; Lai & Wu, 2010; Marzano, Pickering, & Pollock, 2001; McNeill, 2009; Pringle & Lamme, 2005; Romance & Vitale, 2012a; Shiau & Hung, 2000; Vitale & Romance, 2012; Werderich, 2014); (2) science reading activities can encourage students to form their own viewpoints and opinions on the nature of science (Chan, 2003; Chen & Hung, 2003; Chen & Wang, 2004; Chiu & Koa, 2006; Ford, Brickhouse, Lottero-Perdue, & Kittleson, 2006; Lin, Cheng, & Chang, 2009; McNeill, 2009; Wang, Cheng, & Wang, 2003; Wang & Wang, 2004; Werderich, 2014); and (3) integrating science trade books into science teaching can enrich the lessons in science concepts, enhance students' problem-solving skills, provide students with an opportunity to verify scientific rules and experience surprises when they make unexpected discoveries, and stimulate students' creativity and thinking skills (Chin, Yang, & Tuan, 2010; Daisey, 1994; Ediger, 1995; Ford, 2006; Ford, Brickhouse, Lottero-Perdue, & Kittleson, 2006; Guzzetti & Bang, 2011; Lai, 2008, 2009; Lamond Price, 2014; Lo & Chang, 2004; Marzano, Pickering, & Pollock, 2001; McNeill, 2009; Nordstorm, 1992; Pringle & Lamme, 2005; Rice, 2002; Rice & Rainsford, 1996; Rice & Snipes, 1997; Romance & Vitale, 2012a; Rosberg, 1995; Scott, 1993; Short & Armstrong, 1993).

Strategies for Science Trade Book Reading

Gallagher, Fazio, and Ciampa (2017) evaluated the use of science trade books or other various texts in elementary science teaching, and indicated that as 21st-century learning through multi-modal literacies evolves, the readability of online, content-based text should be evaluated to ensure accessibility to all readers. Gallagher, Fazio, and Ciampa (2017) emphasized that teachers should be aware of the limitations of readability indices and be well informed when making instructional decisions based on the most appropriate readability measures for content area texts: teachers are the last line of text scrutiny for instructional appropriateness.

Rice, Dudley, and Williams (2001) suggested that teachers should not only select interesting reading materials when choosing science trade books for science teaching, but should also consider the following factors: (1) whether science concepts are specifically presented in the book; (2) whether stories in the book are genuine; (3) whether it is possible to separate the scientific facts from science fiction; (4) whether there is hasty generalization; (5) whether the descriptions are accurate; (6) whether gender equality is considered in the characters; (7) whether the animal and plant roles are naturally presented; (8) whether the description of the era is correct; (9) whether the statement of the story can enhance a positive attitude toward science; and (10) whether students are willing to read or listen to the book.

Atkinson, Matusevich, and Huber (2009) proposed a rubric to assist teachers in making informed decisions about science trade books for use in classrooms. Criteria in the rubric relate to science content, genre, writing style, illustrations, readability, and text features. The National Science Teachers Association (2014) made some suggestions for the selection of science trade books for science teaching, including (1) the book has substantial science content, (2) information is clear, accurate, and up-to-date, (3) theories and facts are clearly distinguished, (4) facts are not oversimplified to the point that the information is misleading, (5) generalizations are supported by facts, and significant facts are not omitted, and (6) books are free of gender, ethnic, and socioeconomic bias. Mayberry (2014) suggested that using trade books to enrich science content and inquiry investigations can be done by combining three elements: (1) teachers who are enthusiastic readers of their favorite books; (2) high-quality trade books on current science topics; and (3) effective strategies to follow the read-aloud to enhance science learning. In addition, Ford, et al. (2006) emphasized that using science trade books should be accompanied by rich discussion and opportunities for retellings and rereadings.

In addition, Lai (2012) suggested other strategies for improving the effectiveness of students' science reading and learning, which include: (1) problem-oriented discussions that can deepen students' understanding of science reading content; and (2) a science corner set-up to help integrate science reading into students' campus life. Rice (2002) also suggested the use of the learning cycle as a teaching model. The learning cycle involves general science teaching paradigms included in the stage of concept exploration and application, and the science reading strategies added in the stage of concept introduction to strengthen students' understanding of science concepts and recognition of the development of science. Miller, Steiner, and Larson (1996) advocated adopting the KWL model to clarify students' scientific misunderstandings. This model integrates science into reading through strategies of K (what I Know), W (what I Want to know), and L (what I Learned). Crook and Lehman (1990) suggested using a five-phase instructional model to enhance students' science and reading comprehension. Moreover, Short and Armstrong (1993) suggested implementing the inquiry cycle approach to explore science by alternating scientific fiction readings and other fiction. Beck, Mckeown, Hamilton, and Kucan (1997) suggested the QtA (Questioning the Author) model, wherein teachers use questions to guide discussions, and students are required to identify, determine, and understand different scientific topics to clarify their misunderstandings of scientific concepts.

Romance and Vitale (2012b) suggested using the Science IDEAS model to promote students' achievement outcomes in science and reading comprehension. This model combines science, reading comprehension, and writing through multi-day science lessons that integrate six Science IDEAS instructional elements (hands-on activities, reading comprehension, journaling/writing, propositional concept maps, prior knowledge/cumulative review, and application activities). To make science reading-aloud successful, Mayberry (2014) emphasized the following procedures: (1) Preview the book to ensure the content is correct, engaging, and developmentally appropriate. (2) Set the stage for the students prior to the reading-aloud. They should be able to witness the reader's enthusiasm. (3) Celebrate the author, illustrator, and subject matter by sharing interesting facts with the students. (4) Read with great expression! Characters portrayed in different voices provoke interest and curiosity for the listeners. (5) Share the pictures. Visuals are an integral part of the read-aloud procedure. (6) Keep the book available. Students enjoy rereading great books that have been read aloud to them. It has been found that students' understanding of different scientific concepts can be enhanced by reading science trade books. Therefore, it is logical to assume that properly using scientific readings into science teaching and learning can help improve students' science learning effectiveness.

Method

A quasi-experimental design was used in this study at an elementary school in New Taipei City. The students of 5th graders included in this study were divided into two groups: an experimental group and a control group. Students in the experimental group (*N*=59) were given instructional strategies on integrating science trade book reading into science learning, while the control group (*N*=59) received traditional instruction. Both groups were given 27 sessions of teaching classes that spanned nine weeks. A total of 13 sessions were allotted for teaching *The Influence of Heat on Matter*, and 14 sessions for *Air and Burning*. Three science trade books were used in science reading for students in the experimental group. Science trade books used during the research included *Amazing Experiments in Textbooks-Comic Chemistry*, *The Heat of the Three Caves of Rabbits*, and *The Passionate Fire*. The science reading strategies provided in the experimental group, included reading science trade books, conducting scientific experiments, drawing mind maps, and participating in group discussions. The research was conducted in three steps: (1) Teachers were asked to use the aforesaid three science trade books to supplement their teaching of *The Influence of Heat on Matter* and *Air and Burning*, extending students' knowledge on the concepts of heat and combustion. (2) Students were asked to conduct scientific experiments on heat and combustion every week to engage in inquiry activities, experience heat and combustion, and better understand the concepts of heat and combustion. (3) Students were asked to create mind maps about heat and combustion, to discuss this in groups, and to report in class everything they had learned from the three science trade books. While the control groups also were provided of three sets of science trade books in the science corner of their classrooms for their individual reading.

This study used two research instruments: the science achievement test and the attitudes toward science scale. The science achievement test was compiled by the author of this study and consists of 30 items to assess students' understanding of the concepts of heat and combustion. The attitudes toward science scale was also compiled by the author of this study and consists of 31 items to evaluate students' attitude towards science on five-point Likert scales. Statistical analyses showed that both the science achievement test (KR_{21} = .80) and attitudes towards science scale (*Cronbach* α = .94) had good reliability. In addition, three science education researchers confirmed that both research instruments had good validity. The results of both instruments underwent *ANCOVA* analysis. In addition, learning feedbacks from the teacher and students in the experimental group were collected and analyzed.

Results and Discussion

Students' Outcomes on the Science Achievement Test

Learning outcomes on the science achievement test were collected, analyzed, with the following results. There were 118 5th graders who participated in this study. The learning outcomes of the science achievement test are presented in tables 1 and 2.

Table 1. *Mean* & *SD* of Science Achievements Test Scores by Groups

Group	*N*	Pre-test		Post-test	
		Mean	*SD*	*Mean*	*SD*
Experimental group	59	15.05	5.28	22.20	4.59
Control group	59	15.46	4.71	21.08	4.94

Table 2. *ANCOVA* of Science Achievements Test Scores by Groups

Source	*SS*	*df*	*MS*	*F*	*p*
Within	1303.967	1	1303.967	112.564	.000
Between	57.011	1	57.011	4.921	.028*
Error	1332.178	115	11.584		

* p< .05

The results show that students in the experimental group had higher scores than students in the control group (F=4.921, p<.05). This indicates that students in the experimental group did better in science achievement test by integrating science trade book reading. That is, integrating science trade book reading with science learning improved students' science understanding.

Students' Outcomes of the Attitudes toward Science Scale

Learning outcomes of the attitudes toward science scale were collected, analyzed, and stated as follows. There were 118 5th graders who participated in this study, and learning outcomes of the attitudes toward science scale are presented in tables 3 and 4.

Table 3. *Mean* & *SD* of Attitudes toward Science Scale by Groups

Group	*N*	Pre-test		Post-test	
		Mean	*SD*	*Mean*	*SD*
Experimental group	59	115.56	19.81	120.03	18.81
Control group	59	116.95	17.90	117.78	20.99

Table 4. *ANCOVA* of Attitudes toward Science Scale by Groups

Source	*SS*	*df*	*MS*	*F*	*p*
Within	24348.415	1	24348.415	128.800	0.000
Between	324.863	1	324.863	1.718	0.192
Error	21739.625	115	189.040		

Although the post-test score of students in the experimental group were higher scores than students in the control group, there was no significant difference between two groups on the outcomes of the attitudes toward science scale.

Feedback from Students and the Teacher

Students in the experimental groups gave the following feedback after science trade book reading was incorporated into science teaching and learning. According to a student named Jeremy:

> Science trade books are more interesting since they contain dialogues and illustrations. They also provide more information. For instance, one of the science trade books gave a clear introduction on a thermos bottle. My knowledge was further broadened by reading the science trade books because they offered additional information on the topic discussed on our textbook.

Jeremy's statements show that students find the science trade books selected by this study and used as supplementary reading materials interesting because they contain exciting dialogues, pictures and illustrations. Further, the science trade books presented scientific information vividly, which piqued students' interest in reading books and exploring the concepts of heat and combustion.

Reading science trade books also promoted students' interest in topics, which encouraged them to borrow more books from the library for supplementary reading. A student named Anthony stated:

> The quiet library has many books, which makes me want to read books. I borrowed additional books from the library which were about heat transfer coefficients and oxygen.

Another student named Madeleine said:

> The library has many books related to the topics that we discussed in class. The library allows us to select books by ourselves. It allows me to look for science books that I find easy to understand. One of the books that I borrowed from the library was about burning.

The statements by Anthony and Madeleine, students who borrowed books from the library, suggest that reading the science trade books selected by this study increased the students' level of interest and encouraged them to borrow supplementary science books from the library after school for further reading.

As part of the teaching strategy adopted in this study, students were required to conduct relevant scientific experiments every week. Some of the feedback from students is as follows;

One of the students named Stewart said:

> Interesting experiments reinforced our impression about what we learned in class. After the experiment, we obtained a firm understanding on heat and burning.

Another student, Teresa, stated:

> The experiment that the teacher asked us to do gave us a chance to verify the phenomenon that we learned in the textbook. After the hands-on practice, I now have a better understanding of heat and burning.

The statements from Stewart and Teresa show that experiments and personal observations allow students to better understand scientific concepts. They obtained a stronger impression about heat and combustion due to hands-on practice and observation. This also shows that students like to learn science via hands-on experiments, allowing them to have fun while learning through experimental exploration.

Teaching strategies used in this study also include group discussion and group sharing. A student named Howard said:

> Group discussions are very interesting. We were able to share our thoughts with our classmates after reading and we were able to learn more during the discussions.

Another student, Rebecca, noted:

> There were times when we had difficulty understanding the information on the science trade books, so we needed to discuss it with our classmates. Through discussion, I was able to understand concepts that I was not able to grasp on my own. Drawing mind maps deepened my understanding of the information on the book.

Howard and Rebecca's statements show that students have a positive opinion towards group discussions and drawing mind maps after reading science trade books. These statements demonstrate that the use of these methods can help them better understand the narrative and science concepts contained in science trade books. Drawing mind maps can only be done by finding keywords on science concepts for which students have a clear understanding. The feedback from the students regarding drawing mind maps shows that their reading and scientific inquiry abilities also improved.

This study also obtained feedback from the teacher, Katharine, who said:

> The reading materials (science trade books) included in this study are in accord with the topics in science class. Therefore, the supplementary reading materials facilitated students' development of science concepts. In addition, the implementation of multiple teaching strategies helped students further understand the scientific materials they have read. The combination of textbooks with experiments enabled students to verify what they have learned from the textbook, the group discussions enabled them to have meaningful learning, and drawing mind maps enabled them to construct their own views and opinions about the scientific knowledge gained and to develop their understanding of the concepts of heat and combustion. In addition, students also proposed that they continue to read science trade books in class; these books can be selected by teachers for them to read, while they also borrow additional books of their own choice in the library.

The feedback of Katharine reveals that students showed great interest in reading science trade books that have vivid vocabulary, dialogues, and illustrations. Students were also able to better understand concepts of heat and combustion because of the strategies used in this study, which included reading science trade books, conducting experiments, discussing in groups, and drawing mind maps, in conjunction with the teachers' explanation and guidance during class. In addition, experiential learning through conducting experiments also deepened students' understanding of science concepts. This shows that the students have a positive attitude towards the integration of science trade books into science class, and they hope that they can continue to learn science through these science trade books. The teacher and students who participated in this study all had a positive and supportive attitude towards the integration of science trade books into science class.

Conclusion

This study integrated three science trade books into science learning and instruction for 5th graders. The results of the science achievement test found that students in the experimental group had significant higher scores than students in the control group. This findings add support to the perspective that using science trade book reading into science learning can enhance students' understanding of scientific concepts (DeVore-Wedding, 2016; Guzzetti & Bang, 2011; Guzzetti & Mardis, 2017; Lai, 2008, 2012; Lai & Wang, 2016; Romance & Vitale, 2012a, Vitale & Romance, 2012; Werderich, 2014). With the attitudes toward science scale, although the post-test score of students in the experimental group were higher scores than students in the control group, there was no significant difference between the two groups on the outcome of the attitudes toward science scale. Finally, students' feedbacks showed that they enjoyed and benefited from integrating science trade book reading into science learning and would like to do more science trade book reading. These feedbacks also support that frequent reading of science trade books can help children engage science learning and develop their interest (Adams & Phillips, 2016; Davis & Krajcik, 2005; Lai, 2012; Lai & Wang, 2016; Mantzicopoulos & Patrick, 2011; Romance & Vitale, 2012a). Therefore, it can be conclude that integrating science trade book reading into science learning is beneficial for 5th graders.

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Author Information

Ching-San Lai
National Taipei University of Education
134, Sec. 2, Ho-ping E. Rd. Taipei, 10671, Taiwan, R.O.C.
Contact e-mail: *clai@tea.ntue.edu.tw*

Kuei-Lin Chan
National Taipei University of Education
134, Sec. 2, Ho-ping E. Rd. Taipei, 10671, Taiwan, R.O.C.

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The Predictive Effect of Some Variables on Fifth and Sixth Grade Students' Scientific Process Skills

Cemal Tosun

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Abstract

The aim of this research was to investigate whether there was a predictive effect of the frequency of laboratory use of students, their academic success and attending various opportunities to learn science outside the classroom on the fifth and sixth grade students' scientific process skills performance (SPSP). Also, it was investigated whether there was a significant relationship between the students' SPSP and the grade level in which the concepts included in the test items were appropriate. The quantitative research methods were used in this study. Data were collected from 458 fifth and sixth grade students. Regression analysis was conducted to determine the effects of the frequency of laboratory use of students, their academic success and attending various opportunities to learn science outside the classroom on students' SPSP. As a result, it was determined that students' academic success was important predictor variables that affect the fifth and sixth grade students' SPSP. It was also determined that the frequency of laboratory use of students had an important predictive effect on students' causal scientific process skills performance (C-SPSP). Additionally, it was determined that various opportunities to learn science outside the classroom such as attending in science fairs and reading scientific journals had an important predictive effect on students' SPSP. Although, it was also determined that the students' SPSP differs according to the grade level, statistically significant relationship was not found between the students' SPSP and the grade level in which the concepts included in the test items were appropriate.

Introduction

In today's world, new knowledge is constantly produced and developed in science education. Contemporary science teaching programs (Next Generation Science Standard [NGSS], 2013) propose research and inquiry-based methods so that their students do not remain under this increasing knowledge. One of the special aims of the Turkish science teaching curriculum in the process of exploration of nature and understanding of the relationship between human and environment, is to adopt scientific process skills and scientific inquiry approach and to find solutions problems encountered in these fields (Ministry of National Education [MoNE], 2017).

The skills necessary to do scientific inquiry is not unique to scientists. The ability of middle school students to make scientific inquiry should be improved (National Research Council [NRC], 1996). Middle school students should be provided opportunities to engage in scientific inquiries. In-class and out-of-school learning environments should be designed to research and inquiry-based learning methods so that students can learn knowledge comprehensively and permanently.

The aim of the science teaching is to improve students' ability to use scientific process skills and to do scientific research (Harlen, 1999). Because students who acquire scientific process skills understand how a scientific research is conducted and students solve the problems they encounter by using scientific methods. Scientific process skills are not only the skills used in the teaching-learning environment at school, but also the skills used in everyday life (Rillero, 1998).In a scientific inquiry, students begin with a question, design an investigation, collect data, produce alternative answers, and communicate the investigate process and results. Individuals deal with their daily life problems using scientific methods. Solving these problems is possible with scientific process skills (Harlen, 1999).

Scientific Process Skills

Koslowski (1996) defines scientific process skills as the application of scientific methods in solving a problem. Scientific process skills are a most important tool to knowledge production and to edit the knowledge produced (Ostlund, 1998). Scientific process skills can be used at every stage of everyday life (Williams, Papiermo, Makel, & Ceci, 2004). Scientific process skills are important because it creates the basis of science education (Myers, Washburn, & Dyer, 2004). It is emphasized as one of the prime gains for the students (Germann, 1989). In addition, scientific process skills should be acquired to students with several activities in science teaching (Huppert, Lomask, & Lazarorcitz, 2002). Scientific process skills are used in decision making (NRC, 1996). Students who acquire scientific process skills are less dependent on their teachers in the class and they become independent learners (Settlage & Southerland, 2007). High-level thinking skills such as questioning, researching, problem solving and communication can be improved via scientific research (Cuevas, Lee, Hart, & Deaktor, 2005).

The Categories of Scientific Process Skills

Scientific process skills are divided into basic and high-level scientific process skills (Saat, 2004; Rezba, 2007). Basic skills are a pre-requisite for higher level skills (Rambuda & Fraser, 2004). Basic skills can be acquired by students from pre-school, while high-level skills can be acquired from the second level of primary education. Students are expected to acquire more complex scientific process skills in middle school. In some researchers, the scientific process skills divided into three as basic, causal and experimental scientific process skills, (Çepni, Ayas, Johnson, & Turgut, 1997).

The basic scientific process skills dimension includes observing, classifying, measuring, communicating, and recording data sub-dimensions. Ango (2002) mentioned that almost every scientific activity of science begins with observation. Classifying is the skill of grouping objects in accordance with their observed features. Measuring is defined as the skill to determine the size of events and objects using appropriate measuring tools. Communication is to convey one's thoughts to others (Martin, 2003, p.86). Data recording is to convert the qualitative and quantitative data that is collected during experiments and observations into a form that is comprehendible by everyone.

The causal scientific process skills dimension includes inferring, predicting, defining operationally and identifying variables sub-dimensions. Inferring is the best estimate related to the reason of an existing situation (Martin, 2003, p.114). Prediction is to express opinion on what might happen in relation with an existing situation (Martin, 2003, p.106). Operational definition is that students know what process they do while experimenting and which tool they use and why. Identifying variables is to identify all variables that can affect the process of an experiment and is to express them.

The experimental scientific process skills consists of sub-dimensions such as hypothesizing, designing an experiment, changing and controlling variables, modeling and data interpretation (conclusion-decision). Hypothesizing is the best expression of the relationship between the variables (Martin, 2003, p.132). Designing an experiment is the skills that include the students' original experiment design to test a hypothesis. Changing and controlling variables is that student to change or to control variables affected by the result and affecting the result and control variables and to identify the relationship between variables. Modeling is the skill of the student to materialize the data that they obtain from the experiment that they have designed to make that data more significant. Decision making is assessing the data obtained from an authentic experiment that is designed by using scientific process skills to come to a decision.

The Potential Variables Effect on Scientific Process Skills

The literature review reveals that students' scientific process skills performance (SPSP) changes according to some demographic characteristics (*e.g.:* Karar & Yenice, 2012a; Zeidan & Jayosi, 2015). Zeidan and Jayosi, (2015)'s study, researchers investigated the difference between the SPSP of female and male students. In the study of Güden and Timur (2016), they investigated the effect of grade level on the middle school students' SPSP. In addition, in the study of Zeidan and Jayosi, (2015), the researchers investigated the effect of school location on the middle school students' SPSP. Böyük, Tanık and Saraçoğlu (2011)'s study which the researchers conducted with sixth, seventh and eighth grade students was investigated the effect of mothers' education level, fathers' education level, number of family members, income level of family, having a computer and a study room on the students' SPSP.

In addition, the studies in the literature also investigated the effect of the teaching approaches and methods on students' scientific process skills level (*e.g.:* Akben, 2015), its relationship between students' SPSP with their attitudes (*e.g.:* Downing & Filer, 1999; Germann, 1994; Lee, Eichinger, Anderson, Berkheimer, & Blakeslee, 1993; Zeidan & Jayosi, 2015) and their academic success (*e.g.:* Karar & Yenice, 2012b). There are also studies that conducted to define the result how measuring the same scientific process skills of test items developed with different contents (*e.g.:* Temiz, 2010). The studies in the literature investigated the effects of science textbooks and curriculums on the students' SPSP and representation status of scientific process skills in textbooks and curriculums (*e.g.:* Soyibo, 1998; Şen & Nakiboğlu, 2012). It is stated in the literature that there are many studies that have been conducted on some demographic characteristics affecting students' SPSP. The author did not find any research related to the predictive effects of frequency of laboratory use of students (FLUS) and students' academic success (SAS) and opportunities to learn science outside the classroom on the students' SPSP.

Importance of the Study

Contemporary science teaching programs (NGSS, 2013; MoNE, 2017) propose research and inquiry-based methods. Because such abilities not solely coordinated the higher order cognitive skills and the scientific process skills (NRC, 1996, p. 23), but also facilitated students' science learning. Students need to develop their scientific inquiry skills to facilitate science learning and to ensure that they are lifelong learners. It is important to provide opportunities to develop scientific process skills to improve students' inquiry abilities. While basic scientific process skills can be acquired from pre-school period, higher level skills can be acquire from middle school. Therefore, it is expected that students will acquire high-level scientific process skills starting with middle school (Ergin, Şahin-Pekmez, & Öngel-Erdal, 2005). This study was carried out with fifth and sixth grade students since it was the first years of middle school.

Many studies have found that the students' SPSS is low (Walters & Soyibo, 2001) or moderate level (Shahali & Halim, 2010). It is important to know the factors that effect of students' SPSP. Educational policy-makers are interested in what factors a more significant impact on students' SPSP. Science teaching is usually carried out in classrooms, laboratories and out-of-classroom learning environments (Orion & Hofstein, 1994). Science education in middle schools should expand beyond the classroom walls and out-of-classroom learning environments offer many opportunities for students to science learning (Carrier, 2009). Observations, presentations and laboratory practices are the best away of identifying students' SPSP (Lavinghousez, 1973). Understanding the change students' SPSP depends on the presentation and applicability of the subject (Buck, Bretz, & Towns, 2008; Pyle, 2008). The reach of the purpose of experimental activities in science courses requires some scientific process skills. These skills are generally applied in the laboratory. The quality of laboratory activities is an important factor in the students' SPSP (Ercan, 1996). The scientific process skills are acquired during the learning process. Hence the factors affecting scientific process skills are found in the process itself (Nwosu, 1991). Therefore, the effect of three learning environments on students' SPSP was investigated in this study.

Teacher's competence, teaching methods, instructional materials, parents' background, gender, school location, school type, teacher sensitivity, students' cognitive abilities and cognitive demands, teachers' experiences, and the family' socio-economic status are some factors that affect students' SPSP (Martina, 2007). Students' SPSP and the factors affecting these performances is important field of study in educational research. But the author did not find any research related to the predictive effects of FLUS and SAS and opportunities to learn science outside the classroom on the students' SPSP.

Aims of the Study

The aim of this research was to investigate whether there are predictive effects of FLUS, SAS and opportunities to learn science outside the classroom on the fifth and sixth grade students' SPSP. Also, it was investigated whether there was a significant relationship between the students' SPSP and the grade level in which the concepts included in the test items were appropriate. The following research questions were sought in this study:

1- What are the predictive effects of FLUS, SAS and opportunities to learn science outside the classroom on the fifth and sixth grade students' basic scientific process skills performance (B-SPSP), causal scientific process skills performance (C-SPSP), experimental scientific process skills performance (E-SPSP) and total scientific process skills performance (T-SPSP).

2- Are there a significant relationship between the students' SPSP and the grade level in which the concepts included in the test items were appropriate?

Method

The correlational-research method was used while identifying whether there were predictive effects of FLUS, SAS and opportunities to learn science outside the classroom on the fifth and sixth grade students' SPSP. The relationship between two or more groups or phenomena is examined in the correlational-research design (McMillan & Schumacher, 2010).

Sample

The sample of the study was composed of totally 458 fifth and sixth grade students from six provinces in Turkey designated via non-random sampling method. Sample group selected by using the convenience sampling method consists of individuals who are available for study easier (Fraenkel & Wallen, 2006, p.99). The sample group was not represent all fifth and sixth grade students in Turkey. Necessary permissions were obtained from the school administrations to collect data. Participation in the test was based on volunteerism. The participants were explained that the test items did not contain questions and situations that would cause personal discomfort. However, if participants feel uncomfortable with questions or any other reason during the participation, they are told that they may stop answering. It has been explained that in case of non-participation or withdrawal from the research, academic achievement, relations with school and teachers will not be affected. Detailed information about the sample group is shown in table 1.

Table 1. The sampling for the application of the scientific process skills test (SPST) (N=458)

		Frequency	**Percent (%)**
Gender	Female	241	52.6
	Male	216	47.2
	Unspecified	1	0.2
	Total	458	100
Grade level			
	Fifth grade	132	28.8
	Sixth grade	326	71.2
	Total	458	100

Data Collection Tools

The SPST developed by Tosun (2017) was employed in the study. This test was developed according to the 5^{th} and 6^{th} grade students. The test includes the acquisitions within the context of "Matter and its Nature" which is covered in several units in the fifth, sixth, seventh and eighth grades. While creating the item pool, the items to be included in the test were mostly based on the fifth and sixth grade science concepts. Some seventh and eighth grade science concepts were also used. The items were included with the basic, causal and experimental scientific process skills dimensions. Academicians and MoNE teachers evaluated the suitability of the SPST questions. Its reliability was ensured via the data collected from 205 fifth and sixth grade students – 140 girls and 59 boys. The answers given to the test items by 205 students were put through item analysis (Tosun, 2017). The each item' difficulty and, discrimination index, and the utility status of each item's distracter and which grade level of the concepts contained in the test items belong to were examined. These can be seen in table 2.

Table 2. The items' difficulty and discrimination indexes

	Sub-dimensions	Renumber	Grade level	Difficulty index	Discrimination index
Basic scientific process skills	Observation	20	Eighth grade	0.32	0.27
	Measuring	19	Eighth grade	0.52	0.35
	Classifying	3	Fifth grade	0.70	0.42
		10	Fifth grade	0.53	0.47
		13	Fifth grade	0.39	0.31
	Communicating	2	Sixth grade	0.39	0.24
	Recording data	1	Sixth grade	0.50	0.38
Causal scientific process skills	Predicting	4	Fifth grade	0.28	0.35
	Identifying variables	5	Fifth grade	0.55	0.36
		6	Fifth grade	0.38	0.36
		21	Eight grade	0.28	0.35
	Inferring	11	Fifth grade	0.40	0.51
	Defining operationally	9	Seventh grade	0.45	0.47
Experimental scientific process skills	Hypothesizing	8	Fifth grade	0.54	0.56
		14	Sixth grade	0.44	0.55
		18	Seventh grade	0.28	0.31
		22	Eighth grade	0.30	0.45
	Design an experiment	17	Sixth grade	0.43	0.53
	Modeling	23	Seventh grade	0.35	0.31
	Conclusion-decision	12	Fifth grade	0.34	0.53
		15	Fifth grade	0.55	0.62
		16	Fifth grade	0.37	0.31
	Changing variables	7	Fifth grade	0.30	0.35

Subsequent to item analysis, a total of 24 items from the basic, causal and experimental scientific process skills dimensions were put through confirmatory factor analysis, after which one item was excluded from the test. In this study, SPST which was developed by Tosun (2017) and containing 23 items in 3 dimensions was used. Below, some of the items included in the basic, causal and experimental scientific process skills dimensions are given (All names mentioned in test items are not the students' real names).

Sample item for the basic scientific process skills

Upon entering the science laboratory, Zehra and her friends find the experimental setup. The experimental setup has two different amounts of the same liquid being heated. The teacher asks the students to find the boiling point of the liquids. Examining the experimental set up observantly, Zehra notices that the lower-amount liquid is giving out vapor and bubbles. Immediately, she writes the thermometer value down. Soon after she sees that the bigger-amount liquid is giving out only vapor and she writes the thermometer value down.

Item3. Looking at the results, the teacher tells Zehra that she has made a mistake. According to the information above, which two concepts classified below did Zehra confuse and make a mistake?

	Concept I	Concept II
A)	Boiling	Evaporation
B)	Evaporation	Condensation
C)	Melting	Freezing
D)	Boiling	Condensation

Sample item for the causal scientific process skills

Ahmet and his family start watching TV after dinner. At the most exciting part, a power cut occurs. Ahmet's father finds some candles so they have some light. The family start to chat, however, the power does not come back even after hours. Ahmet's mother brings additional candles when the current ones start to melt away. The power cut gets longer and Ahmet brings another candle. Even though the candles brought by the father, the mother and Ahmet are made of the same material; they have the same length; and they are lit in the same room temperature, they last different periods of time since their diameters are different.

Item5. Which one of the below is the independent variable in this sample problem?

A) The material the candles are made of
B) The lasting time of the candles
C) The diameters of the candles
D) The difference in the candles' length

Sample item for the experimental scientific process skills

Melis goes on a tour in Cappadocia with her family in the summer vacation. She convinces her father to take a touristic hot-air balloon ride. Looking for answers to many questions in her mind about the processing principle of the balloons, Melis observes the ride. She notices that the balloon is initially filled with cool air via a powerful fan up to a certain point; and then it is elevated with the heating of the air with heaters.

Item14. With her observation, which of the below hypotheses does Melis test?

A) Hot air is lighter than cool air.
B) Cool air is lighter than hot air.
C) The balloon was elevated by the wind.
D) The balloon will also rise if it is filled with helium which has a lower density than air

Data Analysis

The students were given 1 point for each correct answer and 0 points for each wrong answer. The t-test was used to determine the relationship between the students' SPSP and the grade level in which the concepts included in the test items were appropriate. The ANOVA was conducted to determine whether there was effect of attending various opportunities to learn science outside the classroom on the students' SPSP. In the next step, the data was analyzed according to some predictor variables. At this step, regression analysis was used.

All of the predictive variables were nominal. Predictive variables such as FLUS, SAS, attending in science trips (AST) attending in science competitions (ASC), attending in science fairs (ASF) and designing projects (DP) and reading scientific journals (RSJ) are the qualitative variables with two categories. Before the regression analysis, FLUS codes were determined as "usually = 1" and "sometimes = 0". Academic success codes were determined as "the previous semester's grade averages 85 and over = 1" and "the previous semester's grade averages below 85 = 0". Science trips, competitions and, fairs codes were determined as "attending = 1" and "not attending = 0". Projects coded were determined as "DP = 1" and "not DP = 0". Scientific journals coded were determined as "RSJ = 1" and "not RSJ = 0". All of the predictive variables were included in regression analysis at the same time.

Results

Descriptive Findings for the SPST

The normality of the data was checked according to the measures of central tendency. It was found that the mode, median and the mean values of the basic, causal, experimental and total scientific process skills, were close. Besides, skewness and kurtosis coefficients are given in table 3.

Table 3**.** Skewness and kurtosis coefficient for sub-dimensions and overall the test

Sub-dimensions	Skewness	Kurtosis
Basic scientific process skills	0.473	-0.154
Causal scientific process skills	0.439	0.007
Experimental scientific process skills	0.386	-0.132
Total scientific process skills	0.629	0.224

When table 3 is examined, it is acknowledged that the data is within the normal distribution range as the skewness and kurtosis coefficients for the total scientific process skills test and the sub-dimensions (the basic, causal and experimental) are between -1 and +1 (Morgan, Leech, Gloeckner, & Barret, 2004).

Reliability for the SPST

The reliability coefficient was calculated using the data gathered from 458 fifth and sixth grade students. The reliability coefficient of the basic scientific process skills sub-dimension was calculated as 0.61. The reliability coefficient of the causal scientific process skills sub-dimension was calculated as 0.57. The reliability coefficient of the experimental scientific process skills sub-dimension was calculated as 0.53. Cronbach's alpha for all dimensions of the SPST was calculated to be 0.62. According to these results, the test is reliable (Shum, O'Gorman, & Myors, 2006).

Confirmatory Factor Analysis

Confirmatory factor analysis was conducted to verify the accuracy of data gathered from 458 fifth and sixth grade students. Confirmatory factor analysis was conducted via the LISREL 8.8 statistics program. The results of confirmatory factor analysis are given in table 4.

Table 4. Confirmatory factor analysis results for SPST

χ^2	sd	χ^2/sd	GFI	AGFI	RMSEA	RMR	SRMR
380.07	227	1.67	0.93	0.92	0.038	0.011	0.052

The ratio of the Chi squared value to the degree of freedom (χ^2/sd ratio) (380.07/227=1.67) is below 3, which means a good fit index (Kline, 2005). The fact that the RMSEA value (0.038) is below 0.05 indicates a good fit index (Jöreskog & Sörbom, 1993). The fact that the GFI fit indexes (0.93) and AGFI fit indexes (0.92) are above 0.90 shows an acceptable fit index. According to Table 4, RMR value (0.011) is below 0.05 indicates a good fit index, while SRMR value (0.052) is below 0.08 indicates an acceptable fit index (Brown, 2006).

Results for Research Question 1

The correlation values among the independent variables were calculated and the results are presented in Table 5.

Table 5. Correlation between all of the variables

	FLUS	SAS	AST	DP	ASF	ASC	RSJ
FLUS	---	0.148	0.189	-0.089	0.154	0.058	0.102
SAS		---	0.034	0.071	0.169	-0.001	0.145
AST			---	0.020	0.105	0.071	-0.069
DP				---	0.031	0.058	0.024
ASF					---	0.092	0.098
ASC						---	0.079
RSJ							---

Correlation values of more than 0.80 means a high correlation between variables (Field, 2005, p.224). When Table 5 is examined it is seen that there is not a high correlation between the predictive variables. Another way to determine the multiple correlations between the predictive variables is to examine the variance inflation factor (VIF) or tolerance values. Tolerance and VIF values were examined as shown in Table 6.

Since all tolerance values were greater than 0.25 and, all VIF values were less than 2.0, acceptable values were obtained for each predictive variable (Keith, 2006). The first research question is to investigate whether there was a predictive effect of FLUS, SAS and attending various opportunities to learn science outside the classroom on the fifth and sixth grade students' B-SPSP, C-SPSP, E-SPSP and T-SPSP. For this, regression analysis was conducted and the data obtained are given in tables 7-10.

Table 6. Tolerance and variance inflation factor (VIF) values

	Tolerance	VIF
FLUS	0.911	1.097
SAS	0.935	1.069
AST	0.944	1.059
DP	0.979	1.022
ASF	0.938	1.067
ASC	0.977	1.024
RSJ	0.953	1.049

The predictive effect of all variables on the B-SPSP

Regression analysis was conducted to identify the predictive effect of FLUS, SAS and attending various opportunities to learn science outside the classroom on the students' B-SPSP (See Table 7).

Table 7. Regression analysis for the predictive effect of all variables on the B-SPSP

Variables	B	Std. Error	β	t	p	Zero-order (r)	Partial (r)
Constant	1.691	0.168		10.042	0.000		
FLUS	0.011	0.163	0.004	0.066	0.947	0.038	0.004
SAS	0.717	0.168	0.226	4.257	0.000	0.279	0.232
AST	-0.156	0.187	-0.044	-0.833	0.405	-0.027	-0.047
DP	0.675	0.162	0.217	4.175	0.000	0.236	0.228
ASF	0.530	0.194	0.145	2.728	0.007	0.190	0.151
ASC	-0.254	0.248	-0.053	-1.027	0.305	-0.023	-0.057
RSJ	0.294	0.159	0.097	1.844	0.066	0.149	0.103

The results of the analysis reveal that FLUS, SAS levels and students' AST, ASF, ASC, DP and RSJ show a significant relationship ($R^2 = 0.159$) with students' B-SPSP ($F_{(7\text{-}318)} = 8.583$; $p < 0.05$). The 7 variables together explain the 15.9% of change in basic scientific process skills scores. SAS levels ($\beta = 0.226$, $p<0.05$), DP ($\beta = 0.217$, $p<0.05$) and ASF ($\beta = 0.145$, $p<0.05$) are significant predictors of the students' B-SPSP.

The predictive effect of all variables on the C-SPSP

Regression analysis was conducted to identify the predictive effect of FLUS, SAS and opportunities to learn science outside the classroom on the students' C-SPSP (See Table 8).

Table 8**.** Regression analysis for the predictive effect of all variables on the C-SPSP

Variables	B	Std. Error	β	t	p	Zero-order (r)	Partial (r)
Constant	1.536	0.150		10.206	0.000		
FLUS	0.343	0.146	0.133	2.351	0.019	0.164	0.131
SAS	0.431	0.150	0.159	2.864	0.004	0.200	0.159
AST	-0.171	0.167	-0.057	-1.020	0.309	-0.031	-0.057
DP	-0.051	0.145	-0.019	-0.353	0.724	-0.018	-0.020
ASF	0.153	0.174	0.049	0.881	0.379	0.098	0.049
ASC	-0.112	0.221	-0.027	-0.505	0.614	-0.012	-0.028
RSJ	0.281	0.142	0.109	1.975	0.049	0.152	0.110

The results of the analysis reveal that FLUS, SAS levels, students' AST, ASF, ASC, DP and RSJ show a significant relationship ($R^2 = 0.077$) with students' C-SPSP ($F_{(7\text{-}318)} = 3.813$; $p < 0.05$). The 7 variables together explain the 7.7% of change in causal scientific process skills scores. SAS levels ($\beta = 0.159$, $p<0.05$), FLUS ($\beta = 0.133$, $p<0.05$), and RSJ ($\beta = 0.109$, $p<0.05$) are significant predictors of the students' C-SPSP.

The predictive effect of all variables on the E-SPSP

Regression analysis was conducted to identify the predictive effect of FLUS, SAS and attending various opportunities to learn science outside the classroom on the students' E-SPSP (See Table 9).

Table 9. Regression analysis for the predictive effect of all variables on the E-SPSP

Variables	B	Std. Error	β	t	p	Zero-order (r)	Partial (r)
Constant	2.024	0.193		10.513	0.000		
FLUS	0.090	0.187	0.026	0.484	0.629	0.080	0.027
SAS	0.581	0.193	0.162	3.016	0.003	0.229	0.167
AST	0.000	0.214	0.000	-0.002	0.998	0.012	0.000
DP	0.341	0.185	0.097	1.842	0.066	0.108	0.103
ASF	0.785	0.222	0.190	3.532	0.000	0.228	0.194
ASC	-0.726	0.283	-0.135	-2.564	0.011	-0.098	-0.142
RSJ	0.546	0.182	0.160	3.001	0.003	0.197	0.166

The results of the analysis reveal that FLUS, SAS, AST, DP, ASF, ASC and RSJ show a significant relationship (R^2 = 0.138) with students' E-SPSP ($F_{(7\text{-}318)}$ = 7.250; p <0.05). The 7 variables together explain the 13.8% of change in experimental scientific process skills scores. ASF (β = 0.190, p<0.05), SAS (β = 0.162, p<0.05), RSJ (β = 0.160, p<0.05) and ASC (β = -0.135, p<.005) are significant predictors of the students' E-SPSP.

The predictive effect of all variables on the T-SPSP

Regression analysis was conducted to identify the predictive effect of FLUS, SAS and attending various opportunities to learn science outside the classroom on the students' T-SPSP (See Table 10).

Table 10. Regression analysis for the predictive effect of all variables on the T-SPSP

Variables	B	Std. Error	β	t	p	Zero-order (r)	Partial (r)
Constant	5.251	0.350		15.000	0.000		
FLUS	0.444	0.339	0.068	1.309	0.191	0.125	0.073
SAS	1.729	0.350	0.254	4.938	0.000	0.330	0.267
AST	-0.327	0.389	-0.043	-0.840	0.401	-0.019	-0.047
DP	0.965	0.336	0.145	2.869	0.004	0.159	0.159
ASF	1.468	0.404	0.187	3.634	0.000	0.247	0.200
ASC	-1.092	0.515	-0.107	-2.121	0.035	-0.067	-0.118
RSJ	1.121	0.331	0.173	3.387	0.001	0.233	0.187

The results of the analysis reveal that FLUS, SAS, AST, DP, ASF, ASC and RSJ show a significant relationship (R^2 = 0.210) with students' T-SPSP ($F_{(7\text{-}318)}$ = 12.085; p <0.05). The 7 variables together explain the 21.0% of change in total scientific process skills scores. SAS (β = 0.254, p<0.05), ASF (β = 0.187, p<0.05), RSJ (β = 0.173, p<0.05), DP (β = 0.145, p<0.05) and ASC (β = -0.107, p<0.05) are significant predictors of the students' T-SPSP.

Additionally, the ANOVA was conducted to determine whether there was effect of attending various opportunities to learn science outside the classroom on the fifth and sixth grade students' SPSP. Results of ANOVA are given in table 11. An examination of Table 11 shows that there is a statistically significant relationship between the frequency of attending various scientific activities and the students' B-SPSP [F(3,376)= 2.981, p<0.05], E-SPSP [F(3,376)= 8.441, p<0.05] and T-SPSP [F(3,376)= 8.726, p<0.05]. To find out in what frequency this difference exists, the Tukey test was conducted to the experimental and total scientific process skills sub-dimensions where the group variances were assumed to be equal. For the basic scientific process skills sub-dimension that the group variances were not assumed to be equal, Tamhane's T2 test results were used. The Tukey test was preferred due to the fact that the number of the groups was high (Sipahi, Yurtkoru, & Çinko, 2008, p.128).

The students' B-SPSP attending in the one science activity (M=2.38, SD=1.37) are lower than those attending in the four different science activities (M=3.13, SD=1.14). The students' E-SPSP attending in the one science activity (M=2.53, SD=1.64) are lower than those attending in the two (M=3.37, SD=1.68) and four different science activities (M=3.78, SD=2.08). Also, the students' T-SPSP attending in the one science activity (M=6.80, SD=2.91) are lower than those attending in the two (M=8.27, SD=3.35) and four different science activities (M=9.26, SD=3.04). This difference is in favor of the students who participate in different science activities. In Table 11, the eta-square values of the students' B-SPSP (η2=0.023) and C-SPSP (η2=0.017) have a small effect size while the eta square values of their E-SPSP (η2=0.063) and T-SPSP (η2=0.065) have a medium effect size.

Table 11. Results of ANOVA according to the frequency of attending in various scientific activities

Sub dimensions	Source	Sum of square	Df	Mean square	F	p	η^2
Basic scientific process skills	Between Groups	19.100	3	6.367	2.981	0.031	0.023
	Within Groups	802.950	376	2.136			
	Total	822.050	379				
Causal scientific process skills	Between Groups	10.890	3	3.630	2.191	0.089	0.017
	Within Groups	622.941	376	1.657			
	Total	633.832	379				
Experimental scientific process skills	Between Groups	70.210	3	23.403	8.441	0.000	0.063
	Within Groups	1042.472	376	2.773			
	Total	1112.682	379				
Total scientific process skills	Between Groups	250.461	3	83.487	8.726	0.000	0.065
	Within Groups	3597.265	376	9.567			
	Total	3847.726	379				

Results for Research Question 2

The second question of our research whether there was a significant relationship between the students' SPSP and the grade level in which the concepts included in the test items were appropriate. The fact that the data was distributed normally, the t-test for independent samples was used to determine whether there was any difference between the fifth and the sixth grade students' SPSP. The data obtained that are given Table 12.

Table 12**.** Independent sample t-test according to the grade level

Sub dimensions	Grade level	N	M	SD	df	t	p
Basic scientific process skills	Fifth grade	132	2.15	1.25	290.247	-3.001	0.003
	Sixth grade	326	2.57	1.51			
Causal scientific process skills	Fifth grade	132	2.02	1.12	290.186	-0.214	0.831
	Sixth grade	326	2.04	1.35			
Experimental scientific process skills	Fifth grade	132	2.59	1.68	456	-1.918	0.056
	Sixth grade	326	2.92	1.65			
Total scientific process skills	Fifth grade	132	6.77	2.75	283.972	-2.570	0.011
	Sixth grade	326	7.54	3.24			

The results of the analysis reveal that (see table 12) the rate of correct answers given to the 23-item test was lower in fifth grade students (M=6.77, SD=2.75) than in the sixth graders (M=7.54, SD=3.24). Considering the item numbers in each dimension of the test (7 items for basic scientific process skills, 6 items for causal scientific process skills, and 10 items for experimental scientific process skills), it can be observed that the students' SPSP is low in the sub dimensions of basic, causal, experimental and total scientific process skills. On the other hand, while there is a significant difference between the students' B-SPSP [t(290.247) = -3.001, p<0.05] and T-SPSP [t(283.972) = -2.570, p<0.05], there is no significant difference between the students' C-SPSP [t(290.186) = -0.214, p>0.05] and E-SPSP [t(456) = -1.918, p>0.05]. This difference is in favor of the 6^{th} graders. Table 13 was formed to determine which items differences significantly.

As shown in table 13, items 10 and 13 in basic scientific process skills sub-dimension, items 4 and 21 in causal scientific process skills sub-dimension, and items 14, 15 and 16 in experimental scientific process skills sub-dimension included a statistically significant difference between the grades. These differences are in favor of the sixth grade students except item 21. The concepts included in items 4, 10, 13, 15 and 16 are appropriate for fifth grade students, the concepts included in item 14 is appropriate for 6^{th} grade students and the concepts included in item 21 is appropriate for eighth grade (See Table 2). According to these results, statistically significant relationship was not found between and the grade level in which the concepts included in the test items were appropriate and the students' SPSP.

Table 13. Items with a significant difference

Items	Grade level	N	M	SD	df	t	p
4	Fifth grade	130	0.17	0.37	303.757	-4.464	0.000
	Sixth grade	317	0.36	0.48			
10	Fifth grade	131	0.27	0.44	262.695	-2.879	0.004
	Sixth grade	325	0.41	0.49			
13	Fifth grade	129	0.16	0.36	297.804	-3.711	0.000
	Sixth grade	322	0.31	0.46			
14	Fifth grade	130	0.18	0.38	282.588	-2.931	0.004
	Sixth grade	319	0.31	0.46			
15	Fifth grade	132	0.33	0.47	255.772	-2.576	0.011
	Sixth grade	323	0.46	0.49			
16	Fifth grade	130	0.10	0.30	339.164	-4.028	0.000
	Sixth grade	315	0.24	0.43			
21	Fifth grade	131	0.49	0.50	235.318	2.192	0.029
	Sixth grade	317	0.38	0.48			

Conclusion and Discussion

In the current study, the predictive effects of FLUS, SAS and attending various opportunities to learn science outside the classroom on the students' B-SPSP, C-SPSP, E-SPSP and T-SPSP was investigated. Within this aim, it was determined that students' success levels are a significant predictor on the students' B-SPSP, C-SPSP, E-SPSP and T-SPSP. This finding is consistent with the results of Karar and Yenice (2012b)'s study which researchers conducted with eighth grade students, and reported that there is a moderately positive and significant relationship between the students' SPSP and SAS in the science. Similar findings were reported by Lee *et al.*, (1993) and German, (1994). Also, it has been reported in the literature that there was a highly positive relationship between the academic success of pre-services teachers and their' SPSP (Sittirug, 1997).

In addition, the predictive effect of FLUS on the students' B-SPSP, C-SPSP, E-SPSP and T-SPSP was investigated. It was found that FLUS was significant predictors on the students' C-SPSP. This findings is consistent with the results of Tamir and Lunetta (1981)'s study which reported that the main purpose of the laboratories is to provide students with scientific inquiry and research skills. In the current study also revealed that FLUS did not have any predictive effect on the students' B-SPSP, E-SPSP and T-SPSP. Recently, hands-on learning methods are used in the world and in Turkey in laboratory practice. Hand-on learning means learning by doing it as simple. In this method, tools are created with simple materials that students use in daily life. With these tools, students observe, explain, comprehend and think about an event or a phenomenon. According to NRC (1996), conducting hands-on science activities does not guarantee inquiry. This suggestion can be interpreted as hands-on science activities made with tools are created using simple materials have no effect on students' inquiry abilities and, thus, students' other SPSP except for the skills to predicting, identifying variables, inferring and defining operationally. Conversely, it has been also reported in the literature that the science teaching carried out with simple tools has a positive effect on the development of students' scientific process skills (Yu & Bethel, 1991). The science experiments carried out with simple tools lead to the development of students' many skills related to science (Klemm & Plourde, 2003).

The results of this study revealed that ASF and RSJ was significant predictor of B-SPSP, E-SPSP and T-SPSP. In addition, DP was a significant predictor of B-SPSP and T-SPSP. ASC was significant predictor of E-SPSP and T-SPSP. This result is consistent with Tosun (2019)'s study that was conducted with seventh and eighth grade students and reported that RSJ or DP were significant predictors of B-SPSP, C-SPSP and T-SPSP. Another aim in this study was to investigate whether there was a significant relationship between the students' SPSP and the grade level in which the concepts included in the test items were appropriate. It was determined in this study that there was no statistically significant relationship between the grade level in which the concepts included in the test items were appropriate and the students' SPSP. The concepts contained in most items are developed in accordance with the fifth grade level. However, the sixth grade students better performance in these items. On the other hand, while there was a significant difference between fifth and sixth grade students' B-SPSP and T-SPSP, there was no significant difference between the students' C-SPSP and T-SPSP. This difference was in favor of the sixth graders. Güden and Timur (2016) investigated the effect of grade level on the middle school students' scientific process skills, and reported that the fifth, sixth and eighth grade students' scientific process skills level was higher than seventh grade students' scientific process skills. Böyük, Tanık and

Saraçoğlu (2011) stated that there was a significant difference between sixth, seventh and eighth grade students' scientific process skills in favor of the eighth graders.

The results of this study revealed that students' SPSP is low in the sub dimensions of B-SPSP, C-SPSP, E-SPSP and T-SPSP. It is reported in the literature that the primary school students' scientific process skills levels are also low (Ango, 2002). A similar result was also put forward by Walters and Soyibo (2001). The aforementioned study also expressed that the high-level scientific process skills of the students is not high. In the study of Shahali and Halim (2010), they developed the test of integrated science process and reported that the primary school students' SPSP was moderate level. The studies by Böyük, Tanık and Saraçoğlu (2011) also reported that the middle school students' SPSP has a moderate level. According to the PISA 2006 results, science education at the middle school level in the world was inadequate in providing the targeted knowledge, skills and understanding (OECD, 2007). Another study conducted with pre-services teachers found the same results (Foulds & Rowe, 1996). Germann and Aram (1996)'s study revealed that students recorded data successfully but failed to achieve results for hypotheses and activities. A research by Griffiths and Thompson (1993) concluded that students limited their observations to the use of their senses; their predicting skills did not improve; and that almost half of them had misconceptions about hypothesizing or, even worse, they confused hypothesizing with predicting correctly. In addition to educational research literature, the most important predictor variables on students' SPSP were found to be SAS levels and ASF and RSJ in this study. Also, no relationship was found between and the grade level in which the concepts included in the SPST items were appropriate and the students' SPSP.

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Author Information

Cemal TOSUN
Bartın University
Education Faculty, Science Education Department
Contact e-mail: *ctosun@bartin.edu.tr*

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Students' Belief Biases Concerning Climate Change and Factors Considered While Evaluating Informal Reasoning Arguments

Perihan Gunes

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Socio-Scientific Issues

Abstract

This study determines whether 9th-grade students have belief biases about the cause of climate change. Furthermore, it determines the factors considered while evaluating the informal arguments about climate change. This study employs a case study, a qualitative research method. Participants included 137 9th-grade students (76 females, 61 males) from three different high schools located in the central district of the city of Aksaray, Turkey. Four types of arguments for climate change were considered: strong-believable, weak-believable, strong-unbelievable, and weak-unbelievable. Each argument contained two questions. One of the questions was related to the strength (strong, weak) of the argument, while the other was linked to the reason why students considered an argument to be weak or strong. The data were analyzed using descriptive statistics and content analysis. As a result, the findings showed that students evaluated various argument types in different ways. Students considered the strong-believable arguments to be the strongest. This was followed by weak-believable, strong-unbelievable, and weak-unbelievable arguments with diminishing strength. The students showed a weak tendency for the argument-based evaluation concerning the reasons for the strength and weak of arguments that included logical reasoning between premises and conclusions. Most of the students focused on the assertion-based evaluations that include the reality of premises and conclusion rather than the relationship between the premises and conclusions. This was followed by the arguments focusing on the relation between the conclusion and premise as well as alternative evaluations independent from the argument and those that considered the different aspects of the issue.

Introduction

In addition to simple decisions we make in our daily lives such as deciding which movie to watch, we have to make decisions about several socio-scientific issues. As individual, we are faced with several socio-scientific issues such as whether it is good to use mobile phones, to eat genetically modified foods, or to use embryonic stem cells in scientific research. Furthermore, we need to consider whether nuclear power stations should be installed or whether humans are having an effect on climate change. However, deciding on socio-scientific issues is difficult. This is because socio-scientific issues include open-ended, ill-structured, and debated problems, in addition to having numerous different viewpoints and multiple solutions (Sadler & Zeidler, 2005a). Moreover, socio- scientific issues often include ethical and moral values (Sadler & Zeidler, 2004).

Individuals undergo a reasoning process before making a decision on socio-scientific issues as well as on other issues. Reasoning is based on arguments, and it is the process of evaluating and constructing an argument (Shaw, 1996). Arguments are structures comprising premises and conclusions (Halpren, 1989; Cited in the study by Shaw, 1996), which should be supported by at least one reason (Angell, 1964; Cited in the study by Zohar and Nemed, 2002). For instance, imagine that you are watching a debate on television, in which two scientists are arguing about genetically modified organisms (GMOs). One scientist is claiming that GMOs are healthy, while the other is countering that they are unhealthy. Both scientists are presenting evidence in support of their claims. At the end of the debate, by considering the arguments of these scientists, the viewers reason to come to a decision whether GMOs are healthy. Their arguments comprise claims and evidences that support these claims.

Educators have proposed that numerous reasoning tasks in classes are informal in nature (Perkins, 1985). Informal reasoning is a type of thinking that especially emerges in socio-scientific issues (Means & Voss, 1996). It is highly effective in discussing socio-scientific issues and decision-making processes (Kuhn, 1993; Sadler, 2004). It differs from formal reasoning characterized by logic and mathematics. Formal reasoning includes well-defined problems with explicit and clear premises, whereas the problems in informal reasoning are not well-defined (Wu & Tsai, 2007). In general, informal reasoning involves the evaluation of complex problems that do not involve definitive solutions (Sadler, 2004). The process of formal reasoning often involves deductive reasoning, whereas the process of informal reasoning often involves inductive reasoning (Zohar & Nemed, 2002). In the process of formal reasoning, the premises supports the conclusion; in informal reasoning, the cause may or may not support the conclusion (Evans, 2002). Informal arguments are often used in situations for or against the conclusion (Shaw, 1996). These involve cognitive and emotional processes (Dawson & Venville, 2009; Sadler & Zeidler, 2005a; Topçu, Sadler &Yılmaz-Tüzün, 2010). Furthermore, informal reasoning is affected by social and ethical considerations as well as technological concerns (Topçu, Yılmaz-Tüzün & Sadler, 2011). It involves belief bias (Tompson & Evans, 2012).

Belief Bias

Reasoning independently of beliefs is a fundamental characteristic of critical thinking and scientific understanding. However, in some situations, beliefs may inhibit individuals' reasoning abilities (Stanovich & West, 1997; McCrudden, Barnes, McTigue, Welch & Macdonald, 2017). When people read ideas consistent with their beliefs, they often produce ideas that support or approve what they read. On the contrary, when they read the ideas that inconsistent with their beliefs, they tend to produce thoughts that refute or disapprove (Kardash & Howell, 2000; Sinatra & Broughton, 2011; Tompson & Evans, 2012). This situation leads to a cognitive bias, which is known as belief bias. Belief bias emerges when individuals accept more belief-consistent information than belief-inconsistent information (Stanovich & West, 1997). Individuals differently evaluate belief-consistent and belief-inconsistent arguments. Unfortunately, individuals more objectively evaluate the relation between premises and conclusion in belief-inconsistent arguments. In contrast, people respond more intuitively by refraining from focusing on the relation between premises and conclusion in belief-consistent arguments. Accordingly, belief-consistent arguments require less effort, whereas belief-inconsistent arguments require more effort (Baron, 1995; Tompson & Evans, 2012; Maier & Richter, 2013; McCrudden, Barnes, 2016). Individuals' belief biases have been noted in many controversial issues (Baron, 1995; Čavojová, 2015; Klaczynski, 2000; Klaczynski & Aneja, 2002; Maier & Richter, 2013; Plous, 1991, Wiley, 2005; Thompson & Evans, 2012; Toplak & Stanovich, 2003).

Climate change is one of the controversial issues, and prior studies have determined that individuals had belief biases in informal reasoning related to this issue. For instance, McCrudden and Barnes (2016) presented high school students with various arguments to reveal whether they had belief biases about climate change. Arguments were structured as "for the influence of humans on climate change" (belief-consistent) or "against the influence of humans on climate change" (belief-inconsistent). They found that high school students preferred belief-consistent arguments more than belief-inconsistent ones. Similarly, in their studies on climate change, Maier and Richter (2013) demonstrated that college students were prone to belief-consistent texts. They revealed that students had the opinion that the current acceleration in climate change resulted from human-made causes rather than natural causes. In the literature, prior studies revealed that belief biases exist not only in evaluation but also in the comprehension of controversial issues. For instance, Plous (1991) determined that after nuclear accidents, opponents of nuclear power drew different conclusions from proponents of nuclear power. In that study, the participants read many examples of nuclear accidents. After reading about the accidents, the proponents indicated that the likelihood of nuclear accidents was less than that expected. In contrast, the opponents indicated that the likelihood of nuclear accidents was greater than that expected. Similarly, Wiley (2005) determined that students remembered more belief-consistent arguments than belief-inconsistent arguments in controversial issues (e.g., whether abortion should be legal in the U.S.). Corner, Whitmarsh and Xenias (2012) provided strong evidence that college students internalized new and controversial information regarding climate change in a biased manner. The limited number of existing studies aimed at identifying students' belief biases about climate change underlies the importance of this study.

The literature review revealed that most of the studies on informal reasoning on socio-scientific issues focused on the styles of reasoning (Dawson & Venville, 2009; Sadler, Zeidler, 2005a; Wu & Tsai, 2007) and identification of argumentation qualities (Dawson & Venville, 2009; Demircioğlu & Uçar, 2014; Sadler & Zeidler, 2005b; Topcu, Sadler & Yilmaz- Tuzun,2010; Wu, & Tsai, 2007). The proposed study has key importance given that very few studies explored how individuals evaluated the quality of given arguments and the factors they take into consideration (Shaw, 1996; Topcu, Yilmaz-Tüzün & Sadler 2011). This study determines whether students have belief biases in their informal reasoning about climate change. In addition, it determines the factors that students consider while evaluating the informal arguments about climate change.

Method

Design

The qualitative research method was used in this study. Data were obtained using a case study, one of the qualitative research designs. The case study examines the researched phenomenon within its own framework of life. In the case study, the boundaries between the phenomenon and its environment are not clear. Used when multiple evidence or data sources are available (Yin,2009). The case study method was employed given that students' climate change phenomenon was addressed in the framework of their daily lives without any external educational interventions. The climate change phenomenon was broadly analyzed by considering a single analysis unit (one school), and therefore, a holistic single case study design was used (Yin,2009).

Participants

Participants included 137 9^{th}-grade high school students (76 females, 61 males) studying in three different high schools in the city of Aksaray, Turkey. Their mean age was 15.4. In Turkey, elementary school includes 1^{st}–4^{th} graders, middle school includes 5^{th}–8^{th} graders, and high school includes 9^{th}–12^{th} graders. The students who participated in the study were taught the subjects concerning climate, weather and climate change in the 8th-grade. Therefore, they had prior knowledge of these subjects. Their comprehensive knowledge of these concepts is important in terms of presenting the informal reasoning skill in the study.

Materials

Argument Evaluation Task

It includes four reason-based arguments concerning the source of climate change. As presented in table 1, the arguments were created using four imaginary characters were adopted from the study by McCrudden and Barnes (2016). An emphasis was put on choosing the names of the imaginary characters among basic and frequently used Turkish names.

Table 1. Strong and weak arguments about the source of climate change

	Believable	Unbelievable
Strong	Ahmet wonders whether the Earth's climate has changed with the industrial revolution. In his research, he determined that global warming has increased over the 150-year time span after the start of the Industrial Revolution. He indicated that large amounts of carbon dioxide were added to the Earth's atmosphere, which prevented heat from escaping, causing this change. Therefore, he decided that humans are affecting the climate.	Kerim wondered whether the Earth's climate has changed with the industrial revolution. In his research, he realized that global temperatures have changed over the 150-year time span before the start of the Industrial Revolution. He determined that the small variations in the Earth's orbit, which can change the amount of solar energy that the Earth receives caused these changes. Therefore, he decided that humans are not affecting the climate.
Weak	Esra wanted to learn whether humans are affecting the climate. In her research, she considered that temperatures are increasing from year to year. For instance, in Turkey, the average temperature in May 2016 was higher than the average temperature in May 2015. Therefore, she decided that humans are affecting the climate.	Derya wanted to learn whether humans are affecting the climate. In her research, she considered that the averages of temperature from year to year are not increasing. For instance, in Nevşehir, Turkey, the average temperatures in the recent year were the same. Therefore, she decided that humans are not affecting the climate.

Arguments comprise premises and conclusions. For instance, information such as global warming increased over the 150-year time span after the begining of the Industrial Revolution and large amounts of carbon dioxide which prevent escaping of heat released to the Earth's atmosphere, that causes global warming are premises of the argument. Considering these premises, the argument's conclusion is that "humans are affecting the climate." Arguments were created by considering the argument type (belief-consistent and belief-inconsistent) and the argument strength (strong and weak). Belief-consistent arguments coincide with the current scientific knowledge, which indicates that climate change is caused by human beings. In contrast, belief-inconsistent arguments indicate that humans are not affecting climate change; therefore, these arguments do not coincide with the current scientific knowledge. Both belief-consistent and belief-inconsistent arguments were supported by strong or weak evidences. The arguments in which the conclusion was supported by the premises were defined as “strong,” and the arguments in which the conclusion was not supported by the premises were defined as “weak.” In the arguments, the time factor was considered as an evidence. In the strong arguments, the 150-year time span, sufficient to observe climate change, was given; in the weak arguments, the 1-year time span, not sufficient to observe climate change, was given. In the argument evaluation task (AET), two questions are related to each argument. The first question is related to the strength of the argument, and the second question is related to why they believe the argument is weak or strong. In the first question, there are “strong” and “weak” options about the argument’s strength. The students respond to the question about the strength of the argument by choosing one of these two options. The second question seeks to explain the reason why they have chosen the option in the first question about the argument’s strength.

Procedure

In the study, the 9th-grade students were asked to respond in the AET. This task included arguments about four imaginary characters and questions about these arguments. The AET began with an explanation about the difference between climate and weather. This explanation was as follows: “Climate and weather are two different concepts. Weather is used to explain the atmosphere’s condition in a specific location for a shorter period of time. However, climate is the average weather pattern that does not change for many years. While the weather involves a period of time such as days, months or couple of years, climate involves a longer period of time such as several decades or even hundreds of years.” Thereafter, the participants were asked to read the argument scenarios of four imaginary characters and answer the following questions. In the first question, the participants were asked to decide whether the argument was weak or strong. In the second question, they were asked to note the reasons for their decision about an argument’s strength (strong/weak).

Analysis

Descriptive statistics were used to analyze the strength of the arguments, and content analysis was used to analyze the reason why arguments were rated as strong or weak by the students. The students’ informal arguments about climate change were evaluated under three themes in the context of content analysis. The first was assertion-based evaluation that considered whether the premise or the conclusion was correct. For instance, about the reason for choosing the argument as weak or strong, one student may indicate that she or he approves or disapproves that humans are changing the climate. Similarly, it is applicable for the premises. The second was argument-based evaluation that indicated whether the conclusion was supported by the premises. For instance, one student may explain that the 150-year-time span is sufficient to infer whether humans are affecting the climate. The third was the alternative-based evaluation in which different aspects of the benefit and truth of the conclusion, which were not given in the argument, were indicated. For instance, students may indicate that climate change might depend not only on the industry but also on other reasons. Four codes about the assertion-based evaluations were determined (truth of the premises, unrealistic evidences, truth of the conclusion, and unrealistic conclusion). For the argument-based evaluation, one code (the relation between the evidence and conclusion) was determined. Similarly, for the alternative-based evaluation, one code (several factors influencing the conclusion) was determined. In the study, inter-rater reliability was used. To this end, the students’ responses were analyzed using two content analyzers. The reliability score was calculated using the formula Agreement/(Agreement + Disagreement) × 100, which was suggested by Miles and Huberman (1994). The reliability score between the raters was determined as 0.86. Miles and Huberman (1994) indicated that the inter-rater scores of 80% and above are reliable. Incompatible codes were included in the study after consensus among the raters.

Findings

In this study, first, students’ prior beliefs regarding whether the source of climate change is human agency were determined. Furthermore, 121 students (88,3%) had prior beliefs that the source of climate change is human, and 16 students (11,7%) had prior beliefs that the source of climate change is not human. Thereafter, students were required to determine the strength of the arguments they read. Table 2 presents the descriptive analysis results for the strength of the argument. As presented in table 2, most students agreed that strong-believable arguments were strong. This was followed by weak-believable, strong-unbelievable, and weak-unbelievable arguments.

Students accepted believable arguments more than unbelievable ones and strong arguments more than weak ones.

Table 2: Descriptive statistics on the strength of arguments

Arguments	Argument's strength	f (%)
Strong-believable argument	Strong	122 (89,1%)
	Weak	15 (10,9%)
	Total	137 (100%)
Strong-unbelievable argument	Strong	64 (46,7%)
	Weak	73 (53,3%)
	Total	137 (100%)
Weak-believable argument	Strong	78 (56,9%)
	Weak	59 (43,1%)
	Total	137 (100%)
Weak-unbelievable argument	Strong	22 (16,1%)
	Weak	115 (83,9%)
	Total	137 (100%)

Table 3. Descriptive statistics on the evaluation of arguments

	Assertion-based evaluation	Argument-based evaluation	Alternative-based evaluation	
	f(%)	f(%)	f(%)	Total
Strong-believable argument	118 (86,1%)	12 (8,8%)	7(5,1%)	137
Strong-unbelievable argument	123 (89,8%)	11 (8%)	3(2,2%)	137
Weak-believable argument	116 (84,7%)	18 (13,1%)	3(2,2%)	137
Weak-unbelievable argument	91 (66,4%)	39 (28,5%)	7 (5.1%)	137

Table 4. Reasons for the strength of the strong-believable argument

Strong-believable argument		f(%)	Student opinions
Assertion-based evaluation	Truth of premises	93 (67,9%)	S1:In Ahmet's view, humans are affecting the climate. This is because each year, negative aspects of industry sector are damaging our Earth in this way. S54: People are developing the technology with the impact of industrial revolution with each passing day; as a result of these developments, they are producing more industrial enterprises and vehicles. Therefore, CO2 emission is increasing.
	Non-realistic premises	4 (2,9%)	S12:Because he could find more reasons to decide. S20: He has not done enough research and has not reached a sufficiently strong source
	Truth of conclusion	18 (13,1%)	S3:This is because as humans are affecting the nature, climate changes occur. S9: This is because humans usually damage the atmosphere, and this causes climate change. S83:Only humans can disrupt the climate, even humans cannot restore the climate they have broken
	Non-realistic conclusion	3 (2,2%)	S7: Climate change is not caused by human beings. S23: Climate is not changeable; therefore, humans cannot affect it.
Assertion-based evaluation	Relationship between the evidence and the conclusion	12 (8,8%)	S98: This is because Ahmet made a research over the 150-year time span after the start of the Industrial Revolution, and in this time span, it becomes clear whether the Earth's climate has changed due to the Industrial Revolution. Therefore, Ahmet's conclusion is a strong conclusion. S104: Strong because he made a research about the subject and obtained information. As his research included the 150-year time span, he has reached the true information.
Alternative -based evaluation	Certain factors affecting the conclusion	7 (5,1%)	S47: This is because non-human organisms also harm the climate. S129: The Earth's climate cannot depend only on industry; therefore, this conclusion cannot be inferred by considering only one reason.

Table 3 indicates that while evaluating the arguments, students considered assertion-based arguments. Assertion-based evaluations were followed by argument-based and alternative-based evaluations. Argument-based evaluations that involved the relation between evidence and assertion were indicated by more students in weak arguments than in strong arguments.

As seen in table 4, while evaluating the strength of the argument in strong-believable arguments, most students made assertion-based evaluations based on the truth of the premises or the conclusion. Many students who made assertion-based evaluations focused on the evidence of the argument. The students indicated that they agreed with the evidence about the Industrial Revolution, and they decided that the argument was strong because these pieces of evidences were consistent with their thoughts. Some students focused on the conclusion of the argument and used expressions about the fact that the conclusion concerning human influence on climate was real. Few students focused on the relation between the evidence and conclusion and the other factors that affect the conclusion.

Table 5: Reasons for the strength of the strong-unbelievable argument

Strong-unbelievable argument		f (%)	Student opinions
Assertion-based evaluation	Truth of premises	44 (32,1%)	S651: In the world, an ice age occurred centuries ago and a great climate change occurred. S89: He is saying that there is the global warming due to small variations in the Earth's orbit. S109: I think it is a strong conclusion. Little variations in the Earth's orbit largely affect the climate; as humans, this is not in our hands.
	Non-realistic premises	39 (28,5%)	S58: I think the small variations in the orbit should be clearly explained; if they can change the climate, they are not small. S93: This is because factors other than humans may also cause climate change, but humans are also a great reason. S96: Humans play an important role in variations in the Earth's orbit. S99: It is a strong conclusion, but, in that period of time, the environmental damages caused by humans may again affect the climate.
	Truth of the conclusion	9 (6,6%)	S20: He arrived at the true conclusion. The effect of humans on the climate cannot be seen. Conditions in that period of time may not be the same in this period of time. S63: It is a strong conclusion because there was not so much mechanization and industrialization before the industrial revolution; they were not affected.
	Non-realistic conclusion	31 (22,6%)	S36: I think humans affect it. S97: The conclusion Kerim reached is a weak conclusion because humans affect the climate.
Argument-based evaluation	Inference between evidence and conclusion	11 (8%)	S18: It is a strong conclusion. By considering the 150 years after the Industrial Revolution, Ahmet concluded that humans are affecting the climate. Besides, Kerim concluded that the climate has changed 150 years before the Industrial Revolution. S108: Kerim conducted a long-term research and made an effort; therefore, it is a strong conclusion.
Alternative-based evaluation	Certain factors affecting the conclusion	3 (2,2%)	S129: This is because the only reason for the fact that it changed before the industrial revolution may not be these small variations.

As seen in table 5, while evaluating the strength of the strong-unbelievable arguments, assertion-based evaluations were mostly indicated by the students. In contrast with strong-believable arguments, the students' tendency to find conclusions as realistic decreased in weak-unbelievable arguments. Simultaneously, the number of those who did not find the conclusion as realistic increased. Students mostly indicated that changes other than human agency might affect the climate, but humans had a huge effect on climate change. Only 8 % of the students could explain the relation between evidence and conclusions. Some students made alternative evaluations by saying that different factors other than the Earth's orbit might also affect the climate.

Table 6. Reasons for the strength of the weak-believable argument

Weak-believable argument		f (%)	Student opinions
Assertion-based argument	Truth of premises	33 (24,1%)	S5: This is because it proves that temperatures increase annually. S29: This is because seeing that the temperature increases year after year, I believe that humans are affecting the climate change. S77: Cosmetic products and the technology used by humans are polluting the nature, and the ozone layer depletes; thus, average temperatures increase year by year.
	Non-realistic premises	32 (23,3%)	S79: This is because there is no explanation for the reason why the temperature was higher in 2016 than that in 2015. It should not be said that 'it affects' without explanation. S95: Weak because it is not sufficient to evaluate only the temperature; thus, more data is needed. S123: Weak because of not doing enough research.
	Truth of the conclusion	49 (35,8%)	S114: I think it is a strong conclusion; humans may affect the climate because it should not be forgotten that everything affects and is affected by everything in the world; it is the law of nature. S122: Climate change emerges as long as humans are using things such as deodorants and perfumes, and this fact shows that humans are changing the climate. S130: This is because it is clearly stated that the factor that increases the temperature is human agency.
	Non-realistic conclusion	2 (1,5%)	S20: The reached conclusion might be possible, but it is a weak conclusion. The effect of each person may be seen even a little, but I think daily and yearly movements of the Earth lead more to this conclusion, so I think it is not related with humans. S119: Humans cannot affect the temperature.
Argument-based evaluation	Inference between evidence and the conclusion	18 (13,1%)	S35: I think a longer period of time can be considered. S55: It is clear that humans are affecting the climate; average annual temperatures may vary; the important thing is whether the average temperatures decrease compared with that in previous years. S77: According to this information, humans affect the weather. Information is insufficient.
Alternative-based evaluations	Certain factors affecting the conclusion	3 (2,2%)	S70: It is a strong conclusion because we are building huge buildings and skyscrapers, and this causes that the sun cannot reach to the ground. S117:I think it is weak because I think it is caused by the differences in the Earth's movements.

As seen in table 6, while evaluating the argument in which the relation between the premise and the conclusion was weak and the conclusion was believable, the students mostly made assertion-based evaluations. In their assertion-based evaluations, most students focused on the truth of the conclusion that "humans are affecting the climate." Contrary to the case of the strong arguments, more students focused on the relation between the premise and the conclusion. Not much difference was observed in the number of students who made alternative-based evaluations.

In the weak-unbelievable argument, the students mostly indicated that the argument was weak. As seen in table 7, most students made assertion-based evaluations. Most students who made assertion-based evaluations (about 34%) attributed the reason of argument's weakness to the non-realistic premises. In addition, some students frequently mentioned that they did not agree with the conclusion that "humans are not affecting the climate." The weak-unbelievable argument was the argument in which the relation between the premise and the conclusion was the most evaluated argument among all arguments. The number of students who made alternative-based evaluations is as much as that stated in other arguments.

Table 7: Reasons for the strength of the weak-unbelievable argument

Weak-unbelievable argument		f (%)	Student opinions
Assertion-based evaluation	Truth of premises	11 (8%)	S1: Each year, temperature variations occur due to the Earth's orbit. S19: It is a strong conclusion because she has found that the annual temperature has not changed but remained the same. S30: Climatic conditions and factors affecting climate has remained the same.
	Non-realistic premises	46 (33,6%)	S11: The fact that the annual temperature is the same cannot explain whether humans negatively affect the climate; it may be that it occurs because they both affect in the same degree. S14: Derya should not remain limited to Nevşehir and Aksaray. She should look at other cities. In the nature, many usable materials are destroyed by humans, and this is negatively affecting the climate. Because there is not much industrialization in Nevşehir and Aksaray, there is no temperature change, but she should have investigated other cities as well. S110: Research done in a restricted area does not reflect the truth
	Truth of the conclusion	9 (6,6%)	S3: I also agree that is true; humans do not have any effect on it. S17: It is difficult for humans to do actions that affect the climate.. S20: The research is correct. Because humans have no effect on climate. Climate has an impact on humans. Even the climate is one of the immigration causes of humans
	Non-realistic conclusion	25 (18,2%)	S75: This is because the things that humans do affect the climate; the explanation is not sufficient. S111: This is not a reason why humans do not affect the climate. I think humans absolutely influence the climate.
Argument-based evaluation	Inference between evidence and conclusion	39 (28,5%)	S81: This is because in Derya's example, there are outcomes of one year; this is weather, and climate cannot change in such little time; it is a weak conclusion. S82: Climate is the average temperature in a wide region that does not change for long years. As Derya did, it cannot be decided by looking at two to three regions and with the average temperature of the one last year.
Alternative-based evaluation	Certain factors affecting the conclusion	7 (5,1%)	S54: It makes no sense to evaluate human's effect on the climate and make decisions accordingly without knowing conditions and industries in the region. S136: Because the construction of these 2 cities may affect the climate (factory, etc.). So their climates can be the same.

Discussion

The main conclusions of the study indicated that students evaluated various argument types in different ways. In terms of the reason for climate change, the students agreed that believable arguments were stronger than unbelievable arguments and that strong arguments were stronger than weak arguments. In particular, the strong-believable argument was found to be strong by most students. This was followed by the weak-believable, strong-unbelievable, and weak-unbelievable arguments in order of diminishing strength.

Similar studies conducted on climate change showed that students evaluated belief-consistent information more positively than belief-inconsistent information (Corner et al., 2012; Maier & Richter, 2013; McCrudden & Barnes, 2016, McCrudden & McTigue, 2019). This implies that belief bias may influence evaluation of informal arguments. The fact that the premises or the conclusions in argument were consistent with students' prior beliefs indicates that the arguments will be more accepted as strong ones.

Most students correctly determined the strength of the arguments. However, in terms of why the arguments were strong or weak, the students showed a weak tendency to the argument-based evaluation, which involves logical reasoning between the evidence and the conclusions. Most students focused on assertion-based evaluations, which involve the truth of premises or the conclusion, rather than focusing on the relation between the premises and the conclusion. Assertion-based evaluation is followed by argument-based evaluations and alternative-based evaluations. Shaw (1996) determined that while evaluating the informal arguments, individuals make more objections to the truth of the conclusion rather than to the relation between the premise and the conclusion.

The argument-based evaluations were indicated in weak arguments compared with those in strong arguments by more students. Especially in weak-unbelievable arguments, the tendency to focus on logical relationships becomes prominent. Studies indicated that individuals approach more objectively to the arguments inconsistent with their prior beliefs, and they focus more on the logical relation between the evidence and the conclusion (Beatty & Thompson, 2012; Thompson & Evans, 2012). In strong arguments, there is no logical basis for rejecting the conclusion, whereas there are logical responses that prevent individuals' emotional reactions in weak arguments (McCrudden et al, 2017). Reasoning may weaken when individuals evaluate the information by considering whether it is consistent with their prior beliefs rather than its qualification (McCrudden & Barnes, 2016). The existing literature showed that there is a need for a more detailed approach beyond teaching the "fundamental components' of a scientific discussion or a scientific method. In general terms, presenting the argumentation language and particularly certain argumentation schemes may help students to improve their reasoning skills (Nussbaum, Sinatra, & Owens, 2012).

The other result of this study is that while evaluating the informal arguments, students considered assertion-based, argument-based, and alternative-based arguments in order. In the strong-believable argument, most students focused on the truth of the arguments' premises. The students who believed that humans affects the climate have based the strength of the argument on strength of the premises by considering the strong evidence in their evaluations. Some students focused on the argument's conclusion. Although they stated that the conclusion that humans are affecting the climate change was true, they could not provide a logical basis about why they agreed with the truth of the conclusion. The students who believed that humans are affecting the climate may agree with the premises and conclusions consistent with their prior beliefs. The premises and conclusions that coincide with prior beliefs may support the agreement that the argument is strong and may explain why the arguments were agreed as strong. Strong evidence may provide strong agreement without providing a logical basis.

In cases when the argument's conclusion conflicts with individuals' prior beliefs, the premise-conclusion relation may not always provide strong agreements, even if they are strong. In the strong-unbelievable argument, the tendency of believing the truth of the conclusions or premises decreased for the students who encountered with the conclusions that conflicted with their prior beliefs. The students who encountered with the conclusions that conflicted with their prior beliefs excluded strong evidence without searching for a logical basis.

In the weak-believable argument in which weak premises were presented, the students' tendency to believe the truth of the conclusion increased. The students who believed that humans affect the climate accepted the conclusion that was consistent with their prior beliefs without providing a logical reason. Weak evidences may cause the students to focus on the conclusion while evaluating the argument. In their evaluations, the students considered weak evidences that were consistent with their prior beliefs. Believability of an argument's conclusion may cause the students to evaluate the weak evidences that positively support their opinions as true.

In the weak-unbelievable argument, the students objected to the premises and the conclusions. The weak evidence and unbelievable conclusions may cause the argument to be evaluated as weak. With regard to all arguments, few students indicated the fact that climate change may be related to different factors other than human agency. The lack of sufficient knowledge concerning the causes of climate change can be cited as the reason for indicating a smaller number of alternative arguments. Consequently, it was determined that the students had belief biases about the reasons for climate change. Besides, it was found that in terms of the reasons for climate change, the students made assertion-based, argument-based, and alternative-based evaluations in order.

For future studies, the following suggestions can be made: in some prior studies, it was determined that the belief bias may significantly decline with education (Baron, 1995; Toplak & Stanovich, 2003). In this context, experimental studies showing the effect of in-class and extracurricular practices on belief biases may be conducted. McCrudden et al. (2017) indicated that perspective-taking is a potential way of decreasing the belief bias. By constructing arguments with different viewpoints, their effect on the belief bias may be tested. Furthermore, similar studies in many socio-scientific issues (global warming, GMOs, ecological footprint, environmental issues, energy sources, etc.) may be conducted on a large scale. Thus, whether belief bias varies across various socio-scientific issues may be investigated. Furthermore, argument examples that were used in this study may be extended and made available for science teachers. Thus, students' argumentation abilities development can be supported.

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Author Information

Perihan Güneş
Aksaray University
Faculty of Education, Department of Science Education
68100 Aksaray-TURKEY
Contact e-mail:*perihanguness@gmail.com*

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Investigation of the Effects of Out-of-School Learning Environments on the Attitudes and Opinions of Prospective Classroom Teachers about Renewable Energy Sources

Umit Izgi-Onbasili

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Abstract

The aim of this study is to investigate the effects of energy resources activities on attitudes and views of prospective classroom teachers about renewable energy resources within the context of out-of school learning environments. In the study, quasi-experimental design without pre-test post-test control group was used. The research was conducted in the spring term of 2017-2018 academic year with an in-depth study plan for a total of 14 weeks with 12 prospective classroom teachers within the scope of Community Service Practices course. Out-of-school learning activities are held in Solar Park House and Akkuyu Nuclear Power Plant Information Center which is Turkey's first nuclear power plant, located in Mersin. In the research, Attitude Scale for Renewable Energy Resources developed by Güneş, Alat and Gözüm (2013) was used. Also, the interview form, which consists of open-ended questions developed by the researcher and the diaries kept by the prospective teachers within the scope of the course were examined by qualitative analysis method. As a result of the research, it was found that there was a significant difference between the pre-test and post-test scores of the prospective classroom teachers regarding the renewable energy resources in favor of the post-test scores.

Introduction

The concept of energy and the sustainability of energy resources have been one of the most important issues and problems in the world from past to present (Külekçi, 2009). Energy sources are divided into renewable and non-renewable energy sources. Renewable energy sources are; solar, wind, geothermal, biomass, hydroelectric, wave and tide. Non-renewable energy sources can be listed as fossil fuels (oil, coal, natural gas) and nuclear energy (Külekçi, 2009: 84). In recent years, due to the rapid increase in the world population and the development of technology, the energy has become a global problem as people consume more energy for a more comfortable life. The quality of the training has a great importance because the correct and effective use of energy resources become a bigger problem day by day (Güneş, Alat & Gözüm, 2013). In this context, especially in science education, the value given to this subject gains importance.

Science course is the most practical and convenient course in which constructivist approach can be applied. In other words, interdisciplinary knowledge is integrated and knowledge is transferred to daily life situations. In this course, it is aimed to examine the environment and universe in which children live. Their easy adaptation to life depends on their observation of the environment in which they live and the ways in which they can achieve results by establishing causal relationships between events as much as possible. In this respect, students should acquire the habit of making objective decisions and making right decisions in science course by examining their environment with scientific methods, which enables them to grow up as individuals who are useful to their environment, family and themselves (Kaptan, 1999). When the Elementary Science course curriculum (MoNE, 2018) is examined, it is seen that the concepts of environment and energy have a very important place. In the science curriculum, it is seen that "Light and Sounds Around Us", "Electric Vehicles" and "Lighting and Sound Technologies", "Simple Electrical Circuits" units and energy and electricity concepts are mentioned in the 3rd grade (MoNE, 2018). In this context, it is important for the prospective classroom teachers to have knowledge about environment and energy types with the courses they take at undergraduate level. In this context, there is a need for educational environments where they can practice by performing experimental methods instead of traditional methods, ask questions directly to experts and compare energy types. Therefore, informal learning environments gain importance in this regard as well as formal learning environments.

In many developed countries there is a decrease in student attitudes towards school perception. Therefore, it is argued that informal learning environments should be utilized more in science teaching. With such science education, students can be more motivated towards school and science. Also out-of-school activities can contribute to students' learning in science. Out-of-school activities should be seen as complementary to formal school rather than competing with the school (Braund & Reiss, 2006). Life experiences of children, both inside and outside the school, have profound effects on school success and functioning in the community (Resnik, 1987).

Informal education environments that allow students to establish an individual relationship with real objects and thus gain positive attitudes, values and new perspectives and acquire persistent information include many social areas (Bozdoğan and Yalçın, 2006: 97). Out-of-school learning is the planned processing of the subjects covered in the curriculum outside the school (museums, science centers, zoos, botanical gardens, aquariums, planetariums, industrial organizations, arboretums, etc.). In other words, it is to use informal education resources for formal education (Salmi, 1993, cited in Ertaş, Şen and Parasızoğlu, 2011). At this point, the most important feature is the controlled, planned and organized out-of-school activities (Aydın, Haşıloğlu and Kunduracı, 2016). When the studies about the learning activities and energy types in the literature are examined, it was determined that out-of-school learning activities had positive effects especially on achievement, attitude and permanent learning. Also it was found to be entertaining and remarkable by the participants (Bozdoğan & Yalçın, 2006; Özdemir, 2010; Ertaş, Şen and Parasızoğlu, 2011; Sontay, Tutar and Karamustafaoğlu, 2016)

One of the important details of this study is; Akkuyu Nuclear Power Plant (Turkey's first nuclear power plant) is present in Mersin province. In the case of the establishment of a nuclear power plant, it is frequently encountered in the media (Akkuyu Nuclear Power Plant, 2019) about the returns to the country and the environment, the conditions for the establishment of the power plant and the measures to be taken. For this reason, the opinions of prospective teachers in Mersin are gaining importance. When other studies conducted with prospective teachers in the literature were examined, it was determined that the opinions of prospective science teachers and prospective social science teachers were obtained (Ateş and Saraçoğlu, 2013; Cansız and Cansız, 2015; Çelikler and Kara, 2011; Özdemir and Çobanoğlu, 2008). Differently; Eş, Mercan and Ayas (2016) examined the views of prospective teachers studying nuclear energy in different branches of science (preschool, science, classroom teaching, social science) in Sinop province. It was stated in the media that a nuclear power plant can be built in Sinop province that's why researchers contributed to the field by taking the opinions of prospective teachers in this province. Therefore, as a result of the two trainings on renewable energy and non-renewable energy sources, they were able to learn and compare the advantages and limitations of energy types directly from the experts and institutions. As this is the first study that was carried out simultaneously in Turkey's first nuclear power plant and the Solar Park House, getting importance.

In this sense, the research conducted by Zyadin et al. (2012) on two different energy types is also remarkable. They researched students' awareness and attitudes towards renewable energy in Jordan, a country that uses large amounts of fossil fuels, despite having high renewable energy resources. This study was conducted by applying a questionnaire to 617 students. As a result of the research, it was found that the students' ability to distinguish renewable energy from non-renewable energy resources was limited. Furthermore, more than 50% of students are unaware of biofuels such as biodiesel and bioethanol. Nevertheless, 87% of the students said that they would prefer renewable energy in the future, even at high prices. This research suggests that energy education should be provided at an early age to reduce environmental problems associated with fossil fuels and to promote renewable energy. In this context, the education of prospective classroom teachers at the university about energy becomes more important. They will also guide their students in the future. This study is already gaining importance both in terms of teaching prospective teachers and through them primary school students about the advantages and limitations of different types of energy.

In this context, in this study, the opinions and attitudes of the prospective classroom teachers about energy resources were evaluated in terms of out-of-school learning activities within the scope of Community Service Practices course. When examining content definition of Community Service Practices course; this course aims to gain the social responsibility awareness to the prospective teachers in a theoretical and practical way and to develop cooperation, solidarity, effective communication and self-evaluation skills during the implementation (Higher Education Council, 2019). Therefore, in the scope of this course, activities such as researching a society related issue and taking part in a project are suggested. So it can be said that the course is suitable for the research. Under the guidance of the researcher, all prospective teachers participated in both Mersin Solar Park House on renewable energy sources and Akkuyu Nuclear Power Plant Information Center as a non-renewable energy source. It was investigated by the researcher how out-of-school learning activities related to different energy types affect prospective teachers' views and whether they make a significant difference in attitudes towards renewable energy sources. Different from other studies, it has been studied especially with prospective classroom teachers. First of all, prospective classroom teachers should be provided with the opportunity of direct practical training. In this way, they can explain better the energy issue to their students. The researcher tried to avoid affecting the opinions of prospective teachers by organizing trips to places related to two different types of energy, especially in terms of objectivity regarding energy types. At the end of the semester, the prospectiveteachers synthesized all the subjects they learned and gave practical training to 4th grade students (80 students) from different primary schools. Through this study, both prospective teachers and primary students learned energy types in detail within the context of out-of-school learning environments. Another important point was that the prospective teachers learned how to organize activities in out-of-school learning environments when they became teachers in the future. They also understood about their students' possible reactions and where they might have difficulty with the process and what they should pay attention to. In this context, the research questions were identified as follows:

1. Do activities related to energy resources within the scope of out-of-school learning environments make a significant difference in the attitudes of prospective classroom teachers towards renewable energy sources?
2. Do activities related to energy resources within the scope of out-of-school learning environments make a significant difference on the sub-dimensions of attitudes of prospective classroom teachers towards renewable energy resources (Demand for Practice, Importance of Education, Country Interests, Environmental Awareness and Investments)?
3. Do the activities related to energy resources within the scope of out-of-school learning environments show a significant difference in the attitudes of prospective classroom teachers towards renewable energy sources according to gender variable?
4. How do activities related to energy resources within the scope of out-of-school learning environments affect prospective classroom teachers' views on the effects of out-of-school learning environments on the education and training process?
5. What are their views on the use of Solar Park House within the scope of out-of-school learning environments regarding energy resources?
6. How do activities related to energy resources within the context of out-of-school learning environments affect prospective classroom teachers' views on energy resources?
7. How do the activities carried out within the scope of out-of-school learning environments affect prospective classroom teachers' views on Akkuyu Nuclear Power Plant?

Method

Research Model

In the study, quasi-experimental design without pre-test post-test control group was used. In this design, the measurements of the dependent variable are obtained before and after the application to the groups (Büyüköztürk et al., 2008). Also qualitative data collection sources were used. The prospective classroom teachers' opinions and the diaries they kept during the semester were analyzed by qualitative analyses. Qualitative analyses can be defined as a qualitative data collection method such as observation, interview and document analysis, and a qualitative process to present perceptions and events in a realistic and holistic way in the natural environment (Yıldırım & Şimşek, 2006).

Study Group

The participants of this study were determined by criterion sampling. The aim of the Community Service Applications course is to produce a social project. Therefore, the sample was determined from the participants who chose this course and went to practice in primary school. So it was carried out with a group of 8 female and 4 male prospective teachers who were attending the Community Service Practices course at a public university in the fall semester of 2017-2018 academic year. At the beginning of the semester, detailed information was given to prospective teachers about the content of the course. They stated that they want to contribute voluntarily to the study.

Application Course

Community Service Practices course, which is a compulsory course of 3 hours and 2 credits, 1 hour of which is theoretical and 2 hours of application per week, has been determined as an application course especially in terms of the relationship between the objectives of the course definition and the course directive to the scope of the research. According to definitions, Community Service Practices course is as follows: Students who take this course; 1. Be sensitive to local problems/produces solutions. 2. Be sensitive to universal problems / produces solutions. 3. Participates actively in solving local and universal problems. 4. Produces new projects against local and universal problems. 5. Takes active role / cooperate in new projects against local and universal problems. 6. Communicates effectively both inside and outside the project while conducting projects. 7. Participates in scientific activities such as panels, conferences, congresses, symposiums as audience, speaker or organizer. 8. Develops self-evaluation skills. 9. Uses creative thinking skills in all these activities (Higher Education Council, 2019).

Out-of-School Learning Environments

Solar Park House: This is an energy facility established on a land of 7.5 acres in Mersin in cooperation with Mersin Mezitli Municipality and Chamber of Mechanical Engineers. In the facility where various models and models related to energy types are available, free training is provided to both university students and primary school students by expert engineers. Currently, the Solar Park House part of the facility has been completed and the trainings are given here. Applications are made in an area consisting of indoor and outdoor areas (garden). There'll be solar powered playground, industrial museum, vegetable and fruit drying area, tomato paste and juice extraction station and energy towers prepared for female producers will be located in the complex (Solar Park House, 2019).

Akkuyu Nuclear Power Plant Information Center: This center is located in Mersin and provides information services to the public. In this center; the informations are provided about the history and the development of the nuclear industry, achievements in physics, the level of energy development and the socio-economic development of Turkey. In this center, the working principle of the nuclear power plant is introduced visually. In this center, visitors can learn about the working principle of a nuclear power plant and its reactors. Visitors include children, students, non-governmental organizations, professional organizations, public institutions and organizations, media representatives, tourists, and all persons seeking information. In addition, free training programs, conferences, seminars, roundtables are held at information centers and joint programs are organized with public institutions and local government organizations (Akkuyu Nuclear Power Plant, 2019).

Application Procedure

The researcher planned the activities to be done during the semester and held a detailed meeting with the prospective teachers at the beginning of the semester. The “Renewable Energy Attitude Scale” and open-ended questions developed by the researcher were applied to prospective teachers. In the first part of open-ended questions they were asked; what the out-of-school learning environments are, whether they want to benefit from out-of-school environments during the education process and why, and what role the teacher should have in such activities. In the second part, they were asked to share the types of energy they know, which ones they prefer, and why. At the same time, prospective teachers were asked to evaluate the visits to both centers in detail. Regular weekly meetings were held with prospective teachers. During the 14 weeks, all prospective teachers kept a regular diary and shared with the researcher every week. Each week after the meeting, the researcher asked a daily question to the prospective teachers and they write their thoughts in the diaries.

Under the guidance of the researcher, all prospective teachers participated in both Mersin Solar Park House on renewable energy sources and Akkuyu Nuclear Power Plant Information Center. Before the trip, prospective teachers were informed about the centers. In the trainings, expert engineers made detailed explanations with various models, devices and presentations. Also they had the chance to compare energy types through various simulations. At the end of both trainings, they tried to learn the answers by asking the experts all the questions they were curious about. Both trips and training lasted approximately two hours. After the visits, one hour meeting was held with prospective teachers to evaluate the trip. The subjects they learned were discussed and asked to reflect their experiences in their diaries. At the end of the term, prospective teachers synthesized all the subjects they learned and applied practical education on the topic of energy to 4th grade students who came from different primary schools. Practices were carried out in Solar Park House which has funny and exciting atmoesphere due to the suitability of physical conditions as an out-of-school learning environment Prospective teachers were divided into three group and designed different activities. Each group went to the Solar Park House in advance and prepared their tables for the event. Plenty of activity materials were provided for each student. Various experiments; digital books, posters about energy with augmented reality, wheel of fortune material, ecological footprint tests were applied under the guidance of the researcher. The researcher worked with prospective teachers at each stage. Thus, in addition to the prospective teachers, 80 primary school students had the chance to participate in an out-of-school activity. The teachers of both classes from the primary school brought the students to the center with the necessary permissions. Prospective teachers prepared a clip reflecting each stage of the research and shared it with the researcher at the end of the semester. The application process is detailed in table 1.

Table 1. Application process

Process	Activities
1. week	• Project content related to out-of-school learning environments was mentioned. • Renewable Energy Resources Attitude Scale-pre-test was applied. • Interview questions - pre-test was applied.
2. Week	• Out-of-school learning environments in Mersin were researched and presented.
3. Week *4. Week*	• A research paper on topics such as education in school learning environments environmental education, education for sustainable development and energy types was given.
5. Week	• Research papers were presented. • Necessary interviews were made for the trips to be organized and permission was obtained. • Information was provided on the day and time.
6. Week	• A trip to Solar Park House was organized. • Prospective teachers participated in practical training by engineers.
7. Week	• An evaluation meeting was held on Solar Park House trip.
8. Week	• Akkuyu Nuclear Power Plant Information Tour was organized. Prospective teachers participated in practical training by engineers.
9. Week	• Akkuyu Nuclear Power Plant Information visit was held for the evaluation meeting.
10.Week	• As a result of both trips, sample activities related to energy were developed for primary school students.
11. Week	• With the guidance of the classroom teacher, permission was given from the school administration in order to organize a trip to Solar Park House at the designated day and time with 4th grade students in a public school.
12. Week	• A trip to Solar Park House was organized with the participation of all prospective teachers and 4th grade primary school students. • Energy was explained to the primary school students by the prospective teachers with the materials and activities prepared.
13.Week	• Trip to Solar Park House was organized for the second time (with 4th grade students from another primary school). • Energy was explained to the primary school students by the prospective teachers with the materials and activities prepared.
14. Week	• Evaluation of the term • Renewable Energy Resources Attitude Scale-posttest was applied. • Interview questions - post-test was applied. • Diaries were collected.

Data Collection Tools

The data collection tools used in the research are presented in detail below.

Attitude Scale for Renewable Energy Resources: As a result of the factor analysis of the attitude scale developed by Güneş, Alat and Gözüm (2013), it was stated that there are four factors named desire to implement, importance of education, country interests, environmental awareness and investments. Scale consists of 26 items including 10 positive and 16 negative. The Cronbach's alpha value for the whole scale is .87 and the reliability of the factors respectively .97, .80, .78 and .72. The variance explained by the final scale is 51.94%.

Interview Questions: The interview form consisting of 10 open-ended questions developed by the researcher based on two expert opinions was used at the beginning and end of the process. The comprehensibility of the questions was applied to two prospective teachers studying in another department. The form consists of two sections. The first section deals with the reflection of out of-school learning activities in science education and the second part deals with questions about energy types.

Diaries: During the semester, all prospective teachers kept regular diaries every week. Each week, they wrote the requested information in their diaries about what was spoken and done in the course within the scope of the questions asked by the researcher for that week. They also shared with the researcher the most interesting events and information that they wanted to share in the process.

Validity, Reliability, Ethics

In order to increase validity and reliability, multiple data collection methods were used to collect the research data. Data diversity method, which is defined as presenting the collected data in a supportive and confirmatory manner, was applied (Yıldırım & Şimşek, 2006). In this study, classroom prospective teachers, Solar Park House and Akkuyu Nuclear Power Plant Information Office as out-of-school learning environments were used as a data source. Forms of open-ended questions, observations held by the researcher in the course each week, and diaries of prospective teachers were used as data collecting method. During the analysis of the data obtained, the relationship and consistency between the information obtained from different methods and sources were examined. The coding of the data obtained from the research was done by a field expert besides the researcher. It was calculated by using Miles and Huberman (1994) 's reliability formula was the reliability of the encoder was found .88. Ethically, the prospective teachers were informed about the research and their names would not be used in the study. Direct quotations are included to indicate remarkable findings. For the confidentiality of prospective classroom teachers' names, K1 and K2 codes were used.

Data Analysis

Analysis of Quantitative Data

In the study, firstly, it was tested statistically whether the data obtained from prospective classroom teachers' attitude towards renewable energy sources showed normal distribution. For this purpose, skewness, kurtosis coefficients, box plot, histogram and line graph and Kolmogorov-Smirnov test were used. Kolmogorov-Smirnov test using the above-mentioned methods, it can be said that the distribution of the data is not normal since the p values are less than 0.05, the skewness-kurtosis coefficients are not in the desired range, the graphs do not provide representations of normality and the sample size is well below the expected number for normality. According to these results, since the data did not meet the parametric test conditions, non-parametric statistics were used in the analysis of the data. In this context, Wilcoxon Signed Ranks test was used to determine whether the activities related to energy resources within the context of out-of-school learning environments create a significant difference on the attitudes of prospective classroom teachers towards renewable energy resources and the sub-dimensions of attitudes. In addition, Mann-Whitney U test was used to determine whether prospective teachers' attitudes towards renewable energy sources differ according to gender. In this study, the level of significance was determined as 0.05. In the study, effect sizes (r) were calculated to determine the strength of the relationship between the variables and values of 0.10, 0.30 and 0.50 were interpreted as small, medium and large effect sizes in the same order (Cohen, 1988). Data analysis was performed using SPSS 23.0 package program.

Quantitative Findings and Interpretation

In relation to the first and second sub-problems of the study, whether the activities related to energy resources within the scope of out-of-school learning environments created a significant difference on the attitudes of the prospective classroom teachers and the sub-dimensions of attitudes towards renewable energy resources was examined by Wilcoxon signed rankings test and the results are given in table 2.

Table 2. Wilcoxen test results of attitudes of prospective classroom teachers regarding renewable energy resources

Attitude Scale for Renewable Energy Resources	Post test-pre test	n	Rank mean	Rank total	z	p	r (effect size)
Application request	Negative rank	0	0.00	0.00	2.94*	0.00**	0.85
	Positive rank	11	6.00	66.00			
	Equal	1					
Importance of education	Negative rank	0	9.00	9.00	2.16*	0.03**	0.62
	Positive rank	11	5.78	57.00			
	Equal	1					
Country Interests	Negative rank	0	3.00	3.00	2.53*	0.01**	0.73
	Positive rank	11	5.78	52.00			
	Equal	1					
Environmental Awareness and Investments	Negative rank	0	3.25	6.50	1.19*	0.06	
	Positive rank	11	5.50	38.50			
	Equal	1					
Total	Negative rank	0	0.00	0.00	2.94*	0.00**	0.85
	Positive rank	11	6.00	66.00			
	Equal	1					

*based on negative rank
**p<0,05

Whether the pre-test post-test scores obtained from the sub-dimensions of the attitudes scale of the prospective classroom teachers about renewable energy resources (application desire, importance of education, country interests and environmental awareness and investments) and the total of the scale showed that the activities related to energy resources within the scope of out-of-school learning environments did not show significant differences. The results of the Wilcoxon Signed Ranks Test are given in table 2. The results of the analysis indicated that the prospective classroom teachers' attitudes towards renewable energy resources application of the activities related to energy resources within the scope of out-of-school learning environments ($z = 2.94$; $p < 0.05$), the importance of education ($z = 2.16$; $p < 0.05$) and while country interests ($z = 2.53$; $p < 0.05$) showed significant difference between the subscale scores and the overall scale ($z = 2.94$; $p < 0.05$), environmental awareness and investments ($z = 1.19$; $p < 0$). , 05) shows that there is no significant difference between the scores obtained from the sub-dimension. When the average and rank totals of the difference points are taken into consideration, it is seen that this difference is in favor of the positive rankings, ie the final test score. According to these results, it can be said that the activities related to energy resources within the scope of out-of-school learning environments have a significant effect on increasing the attitudes of prospective classroom teachers towards renewable energy sources apart from the environmental awareness and investments sub-dimension.

As a result of the analyses, when the effect sizes for the Wilcoxon signed rankings test were examined for the sub-dimensions and overall scale. It was found 0.85 for the application request sub-dimension, 0.62 for the sub-dimension of the importance of education, 0.73 for the sub-dimension of the national interests and 0.85 for the overall scale of the scale. Accordingly, the sub-dimensions of the scale and the overall impact of the scale are high, and it can be said that the difference between the pre-test post-test scores regarding the attitudes of renewable energy sources apart from the environmental awareness and investments sub-dimension of the activities related to energy resources within the scope of out-of-school learning environments can be said to be large.

In relation to the third sub-problem of the research, Mann-Whitney U test was used to determine whether the attitudes of the prospective classroom teachers towards renewable energy sources differed according to gender within the scope of out-of-school learning environments. When table 3 is examined, the desire to apply the attitudes of the prospective classroom teachers towards renewable energy resources ($U = 15.50$; $p > 0.05$), the importance of education ($U = 11.00$; $p > 0.05$), the national interests ($U = 11.00$; $p > 0.05$) = 15.50; $p > 0.05$), environmental awareness and investments ($U = 15.50$; $p > 0.05$), the average of the subscales and overall scale ($U = 15.00$; $p > 0.05$) did not show significant differences according to gender. This finding shows that gender does not have a significant effect on the attitudes of prospective classroom teachers about renewable energy sources, in other words, there is no significant difference between male and female classroom teacher candidates' attitudes towards renewable energy sources.

Table 3. Mann-Whitney U test results of attitudes of prospective classroom teachers regarding renewable energy resources

Attitude Scale for Renewable Energy Resources	Gender	n	Rank mean	Rank total	U	p
Application request	Female	8	6.56	52.50	15.50	0.93
	Male	4	6.38	25.50		
Importance of education	Female	8	7.13	57.00	11.00	0.46
	Male	4	5.25	21.00		
Country Interests	Female	8	6.44	51.50	15.50	0.93
	Male	4	6.63	26.50		
Environmental Awareness and Investments	Female	8	6.44	51.50	15.50	0.93
	Male	4	6.63	26.50		
Total	Female	8	6.63	53.00	15.00	0.93
	Male	4	6.44	25.00		

Analysis of Qualitative Data

Content analysis was used in the analysis of open-ended questions and diaries of the prospective classroom teachers. The main purpose of content analysis is to reach the concepts and relationships that can explain the collected data. In this research, qualitative datas were analyzed according to content analysis; data coding, finding themes, editing codes and themes, defining and interpreting the findings were analyzed in accordance with the titles (Yıldırım and Şimşek, 2006: 227-228). Creswell and Plano-Clark (2007) emphasize that it is important to strengthen research by different researchers' analyzing codes and categories in qualitative research. In this study, the answers given to open-ended questions were analysed by two experts. Categories and codes were determined according to similarities and presented as tables with frequency values.

Qualitative Findings and Interpretation

Regarding the fourth sub-problem of the study, it was sought to answer the question of how the activities carried out within the context of out-of-school learning environments affected the prospective classroom teachers about the effects of out-of-school learning environments on the education and training process. For this sub-problem answers of these questions were seeked; "What are the out-of-school learning environments, whether they want to benefit from the out-of-school environments in teaching process and what are their reasons, what is the role of the teacher in such activities".The results of the content analysis of the responses of the prospective teachers are stated in the table 4-5-6-7-8.

Table 4. Prospective classroom teachers' views on out-of-school learning environments

Pre-test	**f**	**Post-test**	**f**
Museums	6	Museums	8
Zoos	5	Zoos	8
Public education centers	4	Planetariums	8
Family	3	Arboretums	5
Home	2	Botanical gardens	5
Neighborhood	2	Aquariums	3
Parks	2	National parks	5
Courses	2	Courses	1
Industry associations	1	Field trips	3
Forests	1	Industry associations	5
		Science centers	2
		Science camps	1
		Historical places	1
		Caves	1
		Nature education	1

When the table 4 is examined, the opinions of the prospective teachers about out-of-school learning environments vary according to the pre-test and post-test status. While they knew a limited number of out-of-school learning environments before the training, they gave more detailed information after the trip. In particular, prospective teachers described family, home, neighborhood and public education centers as out-of-school learning environments. After the education, diversity of information (planetarium, arboretum, national parks, science centers, etc.) and frequency values increased in terms of what is out of school learning environments.

Table 5. Prospective classroom teachers' views on the role of the teacher in the learning environment outside the school

Pre-test	f	Post-test	f
No role	2	Student responsibility	6
His role is minimal	2	Topic knowledge	4
Responsibility	2	Good planning	3
		Time management	2
		Providing a secure environment	2
		Obtaining required permissions	2
		Setting up transport	2

In table 5, when the prospective teachers' views on the role of the teacher in the learning environment outside the school are examined; more clear opinions were obtained according to the post-test results. In the preliminary interview, only the superficial answers such as "teacher has no role, his role is minimal" were said. But after the training, they stated all the responsibilities that the teacher should take when the activity is going to be done in an out-of-school environment. Particularly in the last two weeks of the study, since they gave education to students from two different primary schools, they learned the process by living. It is understood that they have learned more clearly what kind of responsibilities they should have as a teacher. Prospective teachers' views on the role of teachers in out-of-school learning environments are as follows:

> K3: First of all, required permissions should be obtained. Both from parents and the place of destination. Also good planning should be made. What should be done during the process should be determined in advance. Finally, it is up to the teacher to guide and control the students.

> K8: The teacher should guide the child. They should prevent and control children's disintegration. It should lead children to the goal and establish the link between purpose and activity.

Table 6. Prospective classroom teachers' views on the benefits of trainings in out-of-school learning environments

Pre-test	f	Post-test	f
Permanent learning	3	Permanent learning	5
Learning by doing	3	Arouse curiosity	4
See what you can't see at school	2	Learning by doing	3
		Learning with fun	3
		Socialization	3
		Developing creativity	3
		Learning information from an expert	2

According to the table 6; when the prospective teachers' opinions about the benefits of the trainings given in out-of-school learning environments are examined, it is seen that the diversity of benefits increases in the post-test. The prospective teachers stated that after the training they attended, it was important that the out-of-school learning environments would provide permanent learning, arouse curiosity, developing creativity, learning information with fun and from an expert person. Prospective teachers' opinions about the benefits of the trainings given in out-of-school learning environments are as follows:

> K4: It affects both content and social context. Students discover what they see, do not forget for a long time, persistence is more.

> K5: Learning becomes more permanent. They become an active student. It increases students' interest in the subject.

> K9: Classroom is not enough for learning. It is beneficial for the students to realize the learning activities outside the school by seeing, experiencing and touching them. That way they get closer to real life. I think they have more benefits than limitations.

K10: The students get the information from the expert. They enter a new environment and attract their attention.

K11: It is more effective in the learning of the students. It ensures a more permanent learning that the student does not forget.

Table 7. Prospective classroom teachers' views on the limitations of out-of-school learning environments

Pre-test	**f**	**Post-test**	**f**
Difficult to control	5	Difficult to control	3
Distractions in different environments	2	Environment security	2
The reluctance of students	2	Cost	2
		Shortage of time	1
		Transportation	1
		Permission	1

In table 7, when prospective teachers' opinions about possible limitations of the trainings given in out-of-school learning environments are examined, it is seen that prospective teachers have different attention on transportation, cost, shortage of time and environment security. It is also noteworthy that pre-test concerns about the difficulty of controlling the process decreased after the training. Prospective teachers' opinions about the limitations of the education given in the out-of-school learning environments are as follows:

K3: In addition to its benefits, having an out-of-school activity for a crowded group can be problematic. The issue of parent permission may also create problems.

K11: Controlling students can be difficult.

Table 8. Prospective classroom teachers' views on applying out-of-school learning activities

Reasons	**f**
Permanent learning	4
Don't wake up	3
Effective learning	3
Gaining different perspectives	2
Concretizing knowledge	2
Learning by doing	2
The desire to become a teacher who makes a difference	1
Research-inquiry method	1
Expert support	1

At the end of the activities an additional question in the final test was asked to the prospective teachers. It was asked that whether they'll plan to take extracurricular learning activities, or not. All of the prospective teachers expressed positive opinion by emphasizing “Absolutely Yes". Table 8 shows the responses and distribution of why they said "Yes". In table 6, similarities (permanent learning and arouse curiosity, learning by doing) are similar to the findings in their general responses to out-of-school learning environments. The desire to be a teacher who makes a difference" is another remarkable finding. Prospective teachers' opinions about whether they plan to take extracurricular learning activities when they become teachers are as follows:

K1: I definitely think. I want to leave positive permanent traces to students' lives. I would like to take them out of school and embody their knowledge and give them a different perspective on the environment and the world. In the classroom there are just so many teachers who tell the lesson, I want to make a difference for the students who know me, I want to be unique, not one of the thousands.

K2: I definitely think. One of my first goals will be to increase my students' interest in research and learning. I believe that it will give them different thinking and different perspectives.

K4: I think positively, because I think it is more effective and lasting to learn with trip observation. Even I'm affected by what I've seen despite my age, and if I'm learning something, I think out-of-school learning is more effective for children.

K8: I will do as much as possible. Because something may not be very effective only when they remain in theory. The school may not be very effective when it stays in theory. The fact that there are many elements that show the logic of the event in the learning environments outside the school increases the persistence of the child by seeing the information learned. If the teacher is insufficient, he can get help from the experts and the questions are answered more clearly.

In relation to the fifth sub-problem of the study, it was sought to answer the question of how the views regarding the use of Solar Park House within the scope of out-of-school learning environments related to energy resources, and their views on their suitability in terms of science teaching. The content analysis of the prospective teachers' responses is stated in table 9.

Table 9. Prospective classroom teachers' views on suitably of Solar Park House in terms of science teaching

Responses	**f**
In Terms of Lecture	
• Suitable for explaining solar energy	7
• Suitable for all renewable energy technologies	6
Venue Features	
• Remarkable	7
• Having fun	3
• Different	2
• Efficient	1
Effects on Teaching Process	
• Learning by doing	5
• Permanent learning	3
• Eligibility for conducting experiments and activities	3
• Understanding the importance of out-of-school activities	2
• Knowledge consolidation	1
• Awareness raising	1
• Learning by exploring	1
• Facilitating the science lesson	1
• Wake up the desire to learn	1
Affective Perspective	
• Like science course	1
• Changing prejudices against science	1
• Experience the pleasure of the teaching	1
• Motivation	1

When the answers were examined, it was found that almost all of the prospective teachers (except one) found Solar Park House suitable for science teaching. The responses of the prospective teachers are grouped under 4 categories as "in terms of lecture, venue features, effects on teaching process, affective perspective". According to the codes obtained; it is clearly seen that in science teaching, especially when explaining energy resources, models can be used and students can learn by doing, so this ensures permanent learning. They stated that science subjects can be embodied here, attention can be drawn to science subjects and thus the desire to learn can be increased. They shared that they could enjoy science, break prejudices against science, increase learning motivation through to this kind of extracurricular learning areas. In spatial terms, although the entire Solar Park House is not yet complete; it is a remarkable, colorful, different and fun place. They emphasized that such positive features attracted the attention of both prospective teachers and students. Prospective teachers' opinions about the reasons of the question: Can science teaching activities be held in Solar Park House? are as follows:

K1: Solar Park house is a suitable environment for out-of-school activity, although it is not yet complete. When the energy park is totally finished, it will be a more attractive out-of-school learning area. As the science course deals with related subjects, activities can be done there occasionally. Students can do experiments in its garden. I think it is a great learning area for science teaching. I was full of prejudices against science. I understood that out-of-school learning environments simplify and understand with both experiments and games, and there are no issues that cannot be solved. I took the pleasure of teaching. It motivated me to produce and present products and teach them a word. My point of view of the science course expanded positively. Thank you for your effords in this activity.

K2: Absolutely practicable. In the Solar Park House, not only solar energy, but also other renewable energy types are included and its importance was explained. This will create awareness among the students. It will help shape their thoughts.

K4: When I went to Solar Park House, I told to myself that I could organize trips like this for my students in the future. I realized that the science course was more fun with research, experimentation and excursions, and a really intriguing lesson.

K7: We learned a lot of things during our Solar Park house tour. We found it to be a very effective place in science teaching. Previously, I had some questions about whether such trips would be useful. But after I realized our trip, I saw how important these trips are. Especially Solar Park house is a very suitable place for science course.

K12: It is very boring for the students when the science course is handled in the classroom. Since science course is difficult, Solar Park house has benefited the students in terms of efficiency. The fact that students are always in the same environment also affects the science course negatively. It was very useful for the students to see the materials made and do the activities in Solar Park House.

In relation to the sixth sub-problem of the study, it was sought to answer the question of how the activities carried out within the context of out-of-school learning environments affect prospective classroom teachers' views on energy resources. For this sub-problem; it was asked which energy sources they know and which sources they prefer to obtain energy. The results of the content analysis of the answers given by the prospective teachers are stated in tables 10 and 11.

Table 10. Prospective classroom teachers' views on energy sources

Pre- test	**f**	**Post-test**	**f**
Renewable		Renewable	
▪ Solar	12	▪ Solar	12
▪ Wind	11	▪ Wind	11
▪ Hydroelectric	5	▪ Hydroelectric	12
▪ Geothermal	4	▪ Geothermal	11
▪ Biomass	1	▪ Biomass	12
		▪ Wave	10
		▪ Hydrogen	6
		▪ Tidal	4
Non-renewable		Non-renewable	
• Fossil fuels		• Fossil fuels	
✓ Petroleum	5	✓ Petroleum	9
✓ Natural Gas*	5	✓ Natural Gas	10
✓ Coal	3	✓ Coal	8
• Nuclear	3	• Nuclear	9

In table 10, it can be seen that especially in the post-test there is a significant increase in the level of knowledge and corrected misconceptions in the answers given by the prospective teachers (*In the pre-test, two prospective teachers say that natural gas is renewable because it it has no smell, so it is a clean energy source. At the end of process they said natural gas is one of renewable energy resource). The concepts of; "*wave, hydrogen, tidal energy"* appear in the post-test. It is remarkable that only one person stated biomass energy in the pre-test, but at the end of study all of them stated biomass energy as a renewable energy source. It is seen that the applied trainings have a meaningful effect on the knowledge levels of the prospective teachers about energy sources.

Table 11. Prospective classroom teachers' views on energy sources preferences

Pre- test	**f**	**Post-test**	**f**
Renewable energy	11	Renewable energy	12
• Solar	5	• Solar	6
• Wind	3	• Wind	2
		• Hydroelectric	2
Non-renewable energy	1	Non-renewable energy	-

When table 11 is examined, it is seen that prospective teachers preferred renewable energy sources in the pre-test except for one. One of the prospective teachers emphasized that non-renewable energy sources can also be depleted and should be used with carefully. At the end of the training, all prospective teachers stated that they would prefer “renewable energy” sources. One of the prospective teachers (K2) preferred both renewable and non-renewable energy sources in the pre-test, and in the post-test she said she'd prefer renewable energy sources very clearly. (K7) preferred “renewable energy” sources in the pre-test. However, in the post-test, she stated that her priority is again “renewable energy” sources, but non-renewable energy can be utilized when not enough.

For the seventh sub-problem of the study, it was tried to answer the question of how the activities carried out within the context of out-of-school learning environments affect classroom teachers' opinions about Akkuyu Nuclear Power Plant. The content analysis of the prospective teachers' responses ise presented in table 12. Prospective teachers stated that their priorities were "renewable energy" as a result of the trainings they participated in two different out-of-school activities. Seven prospective teacher stated negative opinions, but five of them stated partly positive* opinions about the nuclear power plant as a result of the training (*they could turn to non-renewable energy sources if necessary). As a result of training at Akkuyu Nuclear Power Plant Information Center, prospective teachers increased their knowledge on nuclear energy. They had the chance to ask all the questions about nuclear energy. They asked the engineers about their concerns and shared that they had serious concerns about nuclear power plant. The opinions in table 12 below are also given as to the reasons for their negative judgments.

Table 12. Prospective classroom teachers’ views on nuclear power plant

Reaosons	**f**
Environmental aspects	
• General probability of damage	5
• Radiation hazard	2
• Clean energy demand	1
Concerns	
• Accident that took place in developed countries	2
• Probability of error due to human factor	2
In terms of country	
• Not suitable for every country	1
• Foreign dependence as a country	1
• High cost	1

When table 12 is examined, the prospective teachers' views on nuclear power plant are gathered in 3 categories in terms of environmental aspects, concerns and in terms of country. According to the codes obtained; prospective teachers stated that they have fears and worries in general due to accidents in developed countries with nuclear power plants in recent years, other human-induced mistakes and possible probabilities such as possible leakage and explosion in the reactors. They shared the concerns that the establishment of a nuclear power plant could cause high costs for our country and that we could be dependent on the country that installed the plant. A prospective teacher stated that it did not seem very convincing that she received a positive answer to every question they asked the expert and therefore did not satisfy her anyway. Prospective teachers' opinions about why they think negative about the nuclear power plant are as follows:

> K1: Although we asked all the questions we had in mind during the Akkuyu Nuclear Power Plant tour, I think we should prefer renewable energy sources. The impact of previous disasters is enormous. I think it is necessary to work to use renewable energy sources more efficiently than this type of energy with high costs and side effects.
>
> K4: I saw that the nuclear power plant to be installed on the trip was installed with the latest technology. I think it was built with care and free from all mistakes. However, I do not have a positivie look on the establishment of a nuclear power plant. Why are we opening a new nuclear power plant while the world is slowly closing down its reactors?
>
> K8: It has been established in a highly surplus number in all developed countries. That's why I look warm to it. The energy it will produce will contribute to the economy of the country. People are afraid

of past events, but this should not be an excuse not to be done. But I think the priority should be for the use of renewable energy sources.

K10: It was nice to hear directly how the generation of nuclear power plant was. But I still don't approve of the construction of this plant. It is not right to prefer nuclear when there are more inexpensive, cleaner energy sources. The effects of Chernobyl are still continuing. Although all precautions have been taken, the explosion is unlikely. The realization of this possibility will also ruin natural energy resources, which we do not have the technology to handle.

Discussion and Recommendations

In this study, as a result of the trainings they participated in two different centers, prospective classsroom teachers' opinions about out-of-school learning environments and their attitudes towards energy resources were examined. As a result of the findings obtained from the quantitative data, it was seen that the activities related to energy resources within the scope of out-of-school learning environments had a significant effect on increasing the attitudes of prospective classroom teachers towards renewable energy resources in general. It was also found that gender did not have a significant effect on the attitudes of prospective classroom teachers towards renewable energy sources. In addition, when the answers given to the open-ended questions were analyzed, the answers given to the question of what could be out of school learning environments increased and varied at the end of the application. As a result of the trainings, prospective teachers stated that they could teach especially in planetarium, arboterum, botanical gardens, national parks, science centers, etc. Another finding is that while prospective teachers had more limited information about energy before education, and at some points incorrect information (such as natural gas is a renewable energy type), when the answers given at the end of the trainings were examined, their learning improved and their knowledge levels increased. They shared that both centers can be used while teaching the concept of energy in science course. All of the prospective teachers stated that their education and practices especially at Solar Park House made their views about *renewable energy sources* more positive and they would still prefer *renewable energy sources* in the first place. They also stated that although Solar Park House did not end, it was highly equipped and effective in terms of science teaching. They stated that when they become teachers, processing science courses in such out-of-school learning environments would help both to lasting learning and to attract children's interest. Instead of using traditional methods, they shared that they wanted to be teachers who made a difference with this kind of different studies. Five prospective teachers said that after training at Akkuyu Nuclear Power Plant Information Center, they removed their incomplete knowledge about nuclear energy, they still preferred "renewable energy sources" in the first place, but they looked a little more favorable to the establishment of "non-renewable energy sources" in the second place in terms of energy production ; All prospective teachers expressed their concerns about possible risks (explosion and leakage, environmental damage, radiation and man-made fault like Chernobyl), and they think that our country may be dependent on foreign countries. All of the prospective teachers stated that we should use especially renewable energy sources such as solar and wind much more because of the geographical position of our country. When these findings are compared with other studies in the literature, it is seen that there are common and different points.

For instance, Eş, Mercan and Ayas (2016) conducted a study with prospective teachers studying in different departments at Sinop University. According to the results; prospective teachers have limited knowledge of nuclear energy; they usually learned this information through the media and most of the them do not want to live in a province with a nuclear power plant. However, their views on the establishment of a nuclear power plant in Turkey (want or do not want) ratios indicated that they are close together. Another important point of the study of Eş, Mercan and Ayas (2016) is the establishment of another nuclear power plant in Sinop after Mersin Akkuyu in our country. Researchers state that they do their studies especially considering this feature. It should be noted that in these two studies, prospective teachers generally have insufficient knowledge of nuclear energy. Also, Öztürk and Altan (2019) conducted a study with science teachers working in Sinop. As a result of the interview, they found that the teachers did not have enough information about the nuclear power plant. It has been determined that science teachers evaluate the socio-scientific issues of nuclear power plants mostly with the dimensions of economy and environment. Similarly, in this study, some prospective teachers stated that they realized that they did not have any clear information about nuclear energy before going to Akkuyu Nuclear Power Plant Information Center. With this activity, it was aimed for prospective teachers to obtain information directly from the first source, to be able to examine the models and to get their opinions after this training. One of the important points of the research is that two different places can be compared for both renewable and non-renewable energy types in order to compare prospective calssroom teachers' energy types.

Özdemir and Çobanoğlu (2008) made the research with 506 prospective teachers studying in social science and science. There was a significant difference between the participants' field of study, class and socio-economic characteristics, and most of the participants (51%) stated that they had no prior knowledge about nuclear energy. The prospective teachers' attitudes towards the establishment of nuclear power plants were determined with their knowledge and epistemological beliefs.Similarly, in this study, prospective classroom teachers stated that they had little knowledge about nuclear energy before training. In the study of Özdemir and Çobanoğlu (2008), male participants had more positive opinion about the establishment of nuclear power plant inTurkey, compared to female participants. In this study, it was found that the gender variable had no significant effect on the attitudes of prospective classroom teachers towards renewable energy sources. It can be concluded that the trainings that have been given affect the prospective teachers at the same level.

Çelikler and Kara (2011) found that social science teachers' awareness of renewable energy was higher than that of mathematics teachers. The main reason for this is that while social science prospective teachers take a course on environmental problems and limitations of natural resources, mathematics prospective teachers do not take any courses. Also acorrding to the results; both group of the prospective teachers stated that wind energy is an important renewable energy source and that all countries should use clean energy sources. In order to maintain the ecological balance renewable energy sources should be used. They also stated that they support the production and use of renewable energy sources.

Liarakou, Gavrilaki and Flouri (2009) investigated the knowledge and attitudes of secondary school teachers towards renewable energy sources in Greece. When the results are analyzed; despite teachers' negativity against nuclear power, 40% think that this resource will dominate the global energy sector in the future, but 27% can not make an estimate. Some teachers involved in this research see nuclear energy as a green energy source for fossil fuels, while others believe it is a threat to humanity and ecosystems. Some teachers see natural gas as the dominant energy source in the future. Although the findings show that teachers are informed about renewable energy sources, they show deficiencies in wind and solar energy technologies. Therefore, the researchers recommend that the integration of these themes into teaching both through out-of-school learning environments. They also proposed to give importance to environmental education for teachers. In this sense, it is seen that applied trainings about different types of energy in out-of-school activities respond exactly to this proposal in this study. As a result of the trainings, significant differences were found in the knowledge levels and attitudes of prospective teachers about energy types. At the end of this study, all the prospective teachers said that they would prefer renewable energy sources. However, 5 prospective teachers partially responded positively to the establishment of Akkuyu Nuclear Power Plant. Although these 5 prospective teachers say that renewable energy sources are still in the first place, nuclear power plants can be established provided that necessary precautions are taken in cases where energy is not sufficient. Therefore, despite their preference for renewable energy, they said "yes" to nuclear energy in case of necessity. Note that in the research conducted by Liarakou, Gavrilaki and Flouri, the majority of teachers said that they would definitely prefer renewable energy, but they could not believe that it would be preferred because of insufficient resources in the future.

Ertaş, Şen and Parusuzoğlu (2011) aimed to determine the effect of out-of-school scientific activities on the levels of “Energy” relating to daily life of 9th grade students. As a result of the research, it was concluded that the out-of-school scientific activities increased the students' understanding of the “energy” issue and their connection with daily life. In this study, as a result of out-of-school activities, prospective calssroom teachers' knowledge level about energy increased. In particular, they corrected their missing and incorrect information.

There are positive and negative perspectives on nuclear power in society. Some people think negatively because of the possibility of an accidental radiation spread. In particular, as a result of some nuclear accidents such as Chernobyl, people's concerns have increased (Kaya, 2012). In this study, when the opinions of the prospective teachers were examined, it was seen that those who think negatively expressed similar concerns (possible harm to humanity due to possible accident and radiation probability) and prospective teachers who expressed some positive opinion (possibility of solution due to increasing cost).

Lee and Yang (2013) investigated high school technology teachers' attitudes towards nuclear energy and their effects on technology education. They interviewed 323 teachers and concluded that most of the high school technology teachers in Taiwan are curious about the news about Japan's Fukushima nuclear disaster. Especially after the Fukushima nuclear disaster in Japan, they look more negative against the establishment of nuclear power plants in Taiwan. They are opposed to extending the service life of nuclear power plants operating in Taiwan. As can be seen, the opinions of teachers working in the provinces where the nuclear power plant are affected by environmental disasters. In this study, prospective teachers stated that they had similar concerns due to the Chernobyl and Fukushima incident.

After the Fukushima incident, several international surveys were conducted to examine the public's attitudes towards nuclear energy. It is seen that countries have different attitudes towards nuclear energy (Kubato, 2012). And Kubato interpreted the reason for the different attitudes; from a cost-benefit perspective, public concern about a future nuclear crisis may be a possible answer. As can be seen, as a result of the accidents experienced, there may be changes in the society's view of the nuclear power plant. During the study, one of the prospective teachers specifically asked for detailed information about the Fukushima accident during his visit to Akkuyu Nuclear Power Plant. He wanted to know what measures were taken as a result of a similar earthquake at the Akkuyu nuclear power plant. For this reason, it can be said that accidents in the world are effective in forming the attitudes of teacher candidates.

Çavuş, Topsakal and Kaplan (2013) determined that informal learning environments are important for the students to gain environmental awareness. Similarly, in this study the prospective teachers stated that out-of-school learning environments are important and necessary. Türkmen (2015) examined the perspectives of primary school teachers on informal education. He determined the following results: teachers said that field trips provide permanent learning for their students. However, they stated that they could not do such activities due to the intensity of the curriculum, bureaucratic procedures and cost. At the same time, they do not do such activities as they do not visit the places they will organize their trips in advance.

In this study, the researcher visited both places and made observations about there. Then, with the official permission of the university, the prospective classroom teachers went to both centers. After the trainings they pondered about what kind of activities they could prepare for primary school students. Türkmen (2015) stated that teachers had anxiety because of their ignorance about the place. Thus, this study also prevented this possible anxiety. As Ertaş, Şen and Parasızoğlu (2011: 184) pointed out, trends in different energy sources, energy transformations, use of renewable energy sources, wind farms, cars running with solar energy, dams opened in our country, oil, petroleum, petroleum, natural gas and more than that, the fact that energy takes place in our lives makes the issue of *"energy"* even more important. Media speech about nuclear power plant in Turkey and rapid changes and developments in the world affect all of us as individuals. For this reason, trainings directly received from experts about the use of energy resources become very important. As a result of the visits to two centers, prospective classroom teachers first eliminated their lack of knowledge about energy. In this way, prospective teachers learned how to answer their students' questions about energy in the future.

In this context, the following recommendations can be made based on the research results: Prospective teachers can be given practical trainings about what kind of activities they can do in out-of-school learning environments and possible limitations and advantages of such environments. Similar studies can be conducted with prospective teachers studying in other departments of educational faculty. Different learning environments can be identified in terms of different disciplines such as science, mathematics, social, visual arts, history, and applied trainings can be increased on subjects specific to each discipline. As this study was conducted in Mersin, out-of-school learning environments in Mersin were investigated in detail by prospective teachers. Applied projects can be done in other specified environments. Similar studies can be carried out in other provinces by identifying specific centers. The main purpose of this study is to examine the opinions, knowledge and attitudes of prospective classroom teachers. In the following studies, the effects of the activities carried out in the learning environments on the primary school students can be examined. In this study prospective classroom teachers emphasized especially "permanent learning", so new studies can be planned to investigate the effect of out-of-school learning environments on permanent learning. Particularly in science courses, trips and activities can be organized to out-of-school learning environments such as botanical gardens, planetarium, arboretum, science centers. Because there are limited number of studies on the effects of such out-of-school learning areas on education. As a result of the trainings given in the areas of out-of-school learning; the effects of students' science achievement, science attitudes, science anxiety, social science attitudes, learning skills, critical thinking skills and etc. can be investgated. The experts are engineers at both centers. However, in order to orginize the activities pedagogically, it may be recommended to cooperate with academicians especially in education faculty.

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Author Information

Ümit İzgi Onbaşılı
Mersin University
Education Faculty, Department of Primary Education
Mersin/Turkey
Contact e-mail: umitizgi@gmail.com

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The Investigation of Preservice Teachers' Epistemological Beliefs, Knowledge Levels and Attitudes regarding Organ Transplantation and Donation

Gulsah Gurkan, Sibel Kahraman

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Abstract

In this study, preservice teachers' epistemological beliefs and attitude/knowledge level regarding organ transplantation and donation (OTD) are investigated according to such demographical variables as gender, department and grade level. Teachers play a fundamental role in providing information to children/adolescents and could influence their attitudes. Organ transplantation is a life-saving hope for many people around the world. But, shortage of organs for transplantation is essentially a universal problem. Having positive attitude and true knowledge to the OTD are essential for teachers that affected students the future attitude toward this topic. The research method was descriptive and cross-sectional. The sample of research was 589 preservice teachers (preschool, classroom and science teachers) in a public university in Turkey's East. Data collection instruments were developed by researchers as valid and reliable questionnaire in order to determine the attitudes and knowledge levels of preservice teachers regarding OTD. In addition, epistemological beliefs scale which adapted to Turkish by Deryakulu and Buyukozturk (2002) was used. The results indicated the high level of knowledge and positive attitudes regarding the OTD and developed epistemological beliefs. In addition, the results of correlation matrix for relationship between attitude/knowledge and epistemological beliefs presents that developed epistemological belief has a positive effect on attitude and knowledge levels. Also, the results showed that there is a low positive relationship between attitude and knowledge level.

Introduction

Organ transplantation is a life-saving hope for many people around the world. However, the number of recipient patients on waiting lists for different organs continues to increase (Council of Europe, 2014). There is a wide gap between demand and supply of donated organs and the shortage of organs is a worldwide problem (Ganta, Pamarthi, & Prasad, 2018). The major concerns causing organ shortage are lack of awareness and correct information among public, myths and misconception clouding organ donation due to religious and cultural barriers, etc. (Adithyan, Mariappan & Nayana, 2017). Undoubtedly, having true information and positive attitude about organ donation process is one of the most important factors decision-making period of organ donation (Saylan, 2014). It is important to determine the attitude of social groups that might have a strong influence on the public opinion, such as medicine staff, teachers, journalists and religious authorities (Febrero et al., 2014). Therefore, it is necessary to provide a suitable platform for encouraging people to organ donation through the involvement of other groups of society (especially teachers) in the culture building practices in this regard.

Educational institutions play the biggest role in generating a solution to controversial issues with both social and scientific dimension such as organ transplantation and donation. Schools, where teacher-student and student-student communication is most common, are places these kinds of controversial and science based issues are addressed with an interdisciplinary approach and by taking beneficence-maleficence situations into consideration. Looking at the factors that affect the decision of organ donation, it is seen that characteristics like race, age, income, education level and gender are also determinative. The common characteristics of organ donors are being young, well-educated and having a high socio-economic status (Ozdag, 2001). Studies in literatures indicated that cadaveric organ donation rates are quite high in countries, which place importance to education about organ donation and are able to create a level of awareness about this issue in society (Ganta et al., 2018; Srivasta & Mani, 2018). In addition to that, comparisons between east-west or developed-developing countries determined that in all societies younger people compared to older people, women compared to men, well educated people compared to less educated people have a more positive view regarding organ donation. It was also found out that people with bachelor's degree or higher education levels accept donating organs more often (Alat et al., 2007). In order to increase organ donation rates, studies suggest that in every level of education from primary to higher education the subject should be addressed, the number of organ donation campaigns should increase and society's positive attitude towards organ donation should be developed by raising awareness (Kocak, Aktas, Senol, Kaya, & Bilgin, 2010).

Teachers in every community are considered as the influential groups and their awareness, attitudes, and performances in various fields would directly and indirectly influence the society (Mohammadpour, Mohammadpour, Ajam-Zibad, & Najafi, 2018). The attitude showed by teachers about organ transplantation and donation (OTD) can considerably affect the attitude of pupils. Teachers, together with the family, the media, and social networks, are the biggest sources of information currently available to adolescents (Febrero et al. 2014).Their role in teaching students and creating positive or negative viewpoints about various subjects is obvious. Their knowledge about issues is a key factor to transfer knowledge to next generation (Khoddami-Vishteh, Ghorbani, Ghasemi, Shafaghi, & Najafizadeh, 2011). Hence, it is essential to identify knowledge levels and attitudes of the teachers, who have a great influence on the next generation of public. The attitude and knowledge that teachers pass on to the students is the basis for their future attitudes towards this subject matter.

Mohammadpour et al. (2018) studied to determine the awareness, attitude, and performance of teachers regarding to organ donation. Their studies showed that despite the average awareness and favorable attitude towards organ donation, unfortunately, there was no proper performance toward donation. This study reported that teachers play an important role in changing the existing opinion to organ donation in students, families and society. In Spain, the results of the study by Febrero et al. (2014) showed that 75% of teachers support the organ donation, and their attitude was influenced by the psychosocial factors. In addition, the results of the study done by Rios et al. (2012) showed that teachers are the educators in the community, training is necessary to increase their awareness level in this regard. Furthermore, Khoddami-Vishteh et al. (2011) showed that the main reasons for not attending the teachers in the process of organ donation included the lack of their awareness of patients with chronic diseases and lack of trust in the organ transplant system. According to the study of Kocaay et al. (2015) a better understanding and growing awareness of the organ donation by the individuals affecting the behavioral beliefs of the community can contribute to the people's positive attitudes towards the organ donation and transplantation.

Due to the close relationship between epistemological beliefs and learning-teaching processes and especially its effects on teachers teaching approaches and way of conceptualizing the teaching, determining preservice teacher's epistemological beliefs is considered important. Epistemological beliefs, which determine teachers point of view regarding scientific knowledge- including the existence and definition of knowledge and the way learning is being realized within this context- might directly affect individuals comprehension and evaluation of the information that exists in individual and social decision making processes in daily life (Demir, 2009; Evcim, Turgut, & Sahin, 2011). The effect it has on individual's beliefs, thoughts and behaviors, required educators to take beliefs in many different categories into consideration in terms of learning and teaching processes.

It was found out that epistemological beliefs are related to various learning orientations such as problem solving, interpretation and conceptual change on controversial issues (Kardash & Scholes, 1996; Qian & Alvermann, 2000). Especially students, who believe knowledge is simple, certain and unchangeable, have the tendency to avoid argumentation and higher anxiety levels in the face of arguments. Similarly Linn and Bell (2000) determined that students, who view science as dynamic and constantly changing structure, i.e. who have more "constructivist epistemic beliefs" regarding scientific knowledge, have the tendency to create more complex and integrated arguments. Schommer-Aikins and Hutter (2002) argued that the more individuals believe in the complex and tentative nature of knowledge, which indicates sophisticated epistemological beliefs, the more they succeed in using informal thinking in an effective way by willingly changing their thinking, holding multiple perspectives, and understanding the complex, debatable and open-ended nature of controversial issues (Ozturk & Yilmaz-Tuzun, 2017).

Epistemic beliefs are acknowledged as the premise of success. In addition to that epistemic beliefs and goals of success are considered as two important structure sets for explaining student's cognitive participation, especially their learning strategies (Buehl & Alexander, 2005). Studies showed that preservice teachers with more field knowledge have developed knowledge transformation skills, express their arguments; preservice teachers with lower field knowledge, on the other hand, have trouble expressing their views (Cross, Taasoobshirazi, Hendricks, & Hickey, 2008; Khishfe, 2012; Sadler & Donnelly, 2006). Demiral and Cepni (2018) concluded that preservice teachers with more field knowledge have more developed skills to convince the other party.

Epistemological beliefs which determine perspectives on scientific information, can directly affect the attitudes, behaviors and perspectives of individuals (Oztuna Kaplan & Cavus, 2016). It is of great importance to analyze the way preservice/inservice teachers define an information about organ transplantation and donation, how they combine it with previous knowledge, how they assess it and what kind of a conclusion they reach.

The Aim of the Study

A great responsibility falls on education given in schools and on teachers, who are inseparable pieces of schools. For those reasons, their attitude and knowledge level toward organ donation become important. They can act as an influential body of the society in institutionalizing the culture of organ donation. In this study, preservice teachers' epistemological beliefs and attitude/knowledge level regarding organ transplantation and donation (OTD) are investigated according to such demographical variables as gender, department and grade level. It is important to determine whether the preservice teachers are different in terms of their thoughts, feelings and behaviors related to the concept of OTD due to the education they receive in different branches. If there is a significant difference in attitudes towards OTD due to the training they receive, this will be discussed in the conclusion. It is important to do research with preservice teachers to get their ideas about socioscientific issues such as OTD because it can provide an insight into both teacher education and practice. The results of these studies can encourage policy-makers to revise teacher education, which currently lacks content through which teachers can develop the necessary skills to teach socioscientific issues in classrooms. The objective of the study is to assess preservice teachers' epistemological beliefs and attitude/knowledge level regarding OTD.

Method

Research Design and Participants

The survey research method, one of the quantitative research methods, was used in this study. Surveys are studies in which the views of the participants on a topic or their characteristics such as interest, skill, attitude or ability are identified (Buyukozturk, Akgun, Karadeniz, Demirel, & Kilic, 2014). Convenience sampling method is used in this research. In the cases where it is difficult or impossible to reach the whole of the sample, researchers can work with appropriate sample groups to represent the study. The sample of the study is composed of 589 preservice teachers who are studying in undergraduate programs of science education, classroom education and pre-school education of a state university in Eastern Anatolia Region in Turkey in the academic year of 2017-2018. Distribution of preservice teachers according to their demographic features is given in table 1.

Table 1. Demographic features of preservice teachers

Demographic Features		**f**	**%**
Gender	Female	493	83.7
	Male	96	16.3
Department	Science Education	174	29.5
	Classroom Education	252	42.8
	Pre-school Education	163	27.7
Grade	1st Grade	151	25.6
	2nd Grade	137	23.3
	3rd Grade	141	23.9
	4th Grade	160	27.2
Total		**589**	**100**

Research Instruments

In this research three different data collection tools were used. These tools are organ transplantation and donation attitude scale (OTDAS), epistemological beliefs scale (EBS), and organ transplantation and donation knowledge test (OTDKT).

Organ transplantation and donation attitude scale (OTDAS)

In the research, in order to determine the attitudes of preservice teachers regarding organ transplantation and donation, the scale developed by Gurkan and Kahraman (2018) was used. The 5-point likert scale, within which validity and reliability studies were done, consists of 20 items. In the attitude scale 11 items refer to negative attitudes and 9 items refer to positive attitudes towards OTD. In the scale statements are graded as follows; “1- Strongly disagree”, “2- Disagree”, “3- Slightly agree”, “4- Agree”, “5- Strongly agree”. As result of the exploratory factor analysis and conducted parallel analysis, in order to verify the two-factor structure and provide structural validity of the scale, confirmatory factor analysis was carried out.

In order to calculate the reliability of 20 items in the organ transplantation and donation scale internal consistency coefficient “Cronbach Alpha” was calculated. General consistency of the scale was found α =0.900. Examining goodness of fit criteria after confirmatory factor analysis $\chi^2/Sd = 1.98$ was found and in case of a χ^2/Sd value of 5 or smaller it is accepted that model data fit is perfect. GFI was found 0.94. Having the value of GFI >.90 points to an acceptable fit (Simsek, 2007). AGFI was found 0.92 and this value shows an acceptable fit. RMR was found 0.041 and having a RMR value <0.050 shows good fit. RMSEA value was found 0.045, having a RMSEA value <0.050 shows good fit (Munro, 2005). Analysis results point out that scale has a good fit in terms of determined factor structure, since fitness statistic model calculated by confirmatory factor analysis is concordant on an acceptable level with real data gathered from the participants.

Epistemological belief scale (EBS)

The Epistemological Belief Scale, which was developed by Schommer (1990) was translated into Turkish by Deryakulu and Buyukozturk (2002). It is a 5-point Likert-type scale (1- strongly disagree, 2- disagree, 3- not sure, 4- agree and 5- strongly agree) and it has a three-factor structure. The first factor of the scale called “The belief that learning depends on effort (BLDE)” consists of 18 items. The second factor of the scale called “The belief that learning depends on ability (BLDA)” consists of 8 items. “The belief that there is only one truth (BTOT)”, the third factor, consists of 9 items.

Organ transplantation and donation knowledge test (OTDKT)

In order to develop the institutional framework of OTDKT, which was developed by researchers, literature was widely reviewed and item pool consists of 30 multiple choice questions regarding organ transplantation and donation was generated by examining the data collection tools used in related research. In the direction of expert views, 10 items were removed from the test and the draft test consists of 20 items was made ready for pretest. For the draft scale performed with 106 Science Education undergraduate students enrolled in their 3 and 4. years TAP statistics program was used for item analysis. As the result of item analysis items with low distinctiveness and difficulty indices were removed and item number was reduced to 12.

For OTDKT mean distinctiveness level was found 0.47, mean difficulty value was found 0.60 (3 items hard, 3 items medium and 6 items easy) and KR-20 reliability coefficient was found 0.706. Provided as evidence for reliability and validity of multiple choice tests developed to measure mental processes, these values should be evaluated together (Downing & Haladyna, 2006; Kubiszyn & Borich, 2013). According to this, examining these values together it can be concluded that scores obtained from the developed test is able to differentiate preservice teachers enrolled in their 1, 2, 3 and 4. years with various cognitive understanding levels regarding organ transplantation and donation; the test is easy difficulty and shows internal consistency (Tekin, 2000).

Data Analysis

In the analysis of the data, besides frequency, percentage and arithmetic mean, "t-test of independent groups" was used in the comparison of two groups whereas "one-way variance analysis (ANOVA)" was used in the comparison of more than two groups. The Tukey HSD test (Post Hoc) was used to determine the groups in which the statistical difference emerged in binary comparisons following the analysis of variance. The significance level in the statistical analysis of the scale was accepted as 0.05.

Results

The purpose of this study is to reveal the attitudes/knowledge levels about OTD and epistemological beliefs of preservice teachers and to examine them in terms of different variables. Relevant results are presented below. Table 2 presents descriptive analysis reliability coefficient OTDAL, EBS (BLDE, BLDA, BTOT) and OTDKL values of mean scores of preservice teachers regarding OTD.

Table 2. Descriptive statistics values about attitudes, knowledge levels regarding OTD and epistemological belief levels

Variables (N=589)	Reliability (Cronbach Alpha Coefficient)	Mean	Standard deviation	Min.	Max.	Skewness	Kurtosis
OTDAL (20≤x≤100)	0.75	77.86	11.81	43.00	100.00	-.062	-.642
OTDKL (0≤x≤12)	0.63	7.77	1.69	3.00	12.00	.003	-.189
BLDE (18≤x≤90)	0.71	33.49	6.17	18.00	54.00	-.161	-.146
BLDA (8≤x≤40)	0.73	18.01	4.54	8.00	33.00	.455	.319
BTOT (9≤x≤45)	0.71	26.35	4.92	10.00	41.00	-.014	-.048

(**OTDAL:** Organ Transplantation and Donation Attitude Level, **OTDKL**: Organ Transplantation and Donation Knowledge Level, **BLDE:** The Belief that Learning Depends on Effort, **BLDA:** The Belief that Learning Depends on Ability, **BTOT:** The Belief that There is only One Truth)

The descriptive statistics analysis shows that the average in the total scores of the attitudes toward OTD is above the medium level. Alpha coefficient of organ transplantation and donation knowledge test was found 0.63 and mean was calculated 7.77. According to this it was found out that preservice teachers' OTD knowledge levels are above average. Considering the average scores of epistemological belief factors (BLDE, BLDA, BTOT) indicate mature epistemological beliefs (Deryakulu & Buyukozturk, 2000). Table 3 presents the results of correlation matrix, which indicates relationship between the preservice teachers' epistemological beliefs and attitudes/knowledge levels about organ transplantation and donation. Pearson Correlation Test was used because the data showed normal distribution.

Table 3. Correlation matrix for relationship between variables

Variables	BLDE Correlation (p)	BLDA Correlation (p)	BTOT Correlation (p)	OTDAL Correlation (p)
The belief that learning depends on effort (BLDE)	-			
The belief that learning depends on ability (BLDA)	0.301 (0.000)	-		
The belief that there is only one truth (BTOT)	0.032 (0.373)	0.381 (0.000)	-	
Organ transplantation and donation attitude level (OTDAL)	-0.165 (0.000)	-0.214 (0.000)	-0.134 (0.000)	-
Organ transplantation and donation knowledge level (OTDKL)	-0.061 (0.085)	-0.165 (0.000)	-0.067 (0.059)	0.128 (0.000)

(p< .05)

When table 3 is examined, it is seen that more than half of the correlation between the variables is significant at 0.05 level and there are positive and negative correlations between some variables. Table 3 shows that there is a negative relationship between the dimensions of the epistemological beliefs and the attitude level; relationship between of the belief that the learning depends on the effort and attitudes (r = -0.165, p = 0.000), relationship between of the belief that the learning depends on the ability and attitudes (r = -0.214, p = 0.000) and relationship between of the belief that there is only one truth and attitudes (r = -0.134, p = 0.000).

The reason for this negative relationship is that the high score obtained from each factor of the epistemological belief scale shows that the individual has immature or undeveloped beliefs related to that factor, while the low score indicates that the individual has matured or developed beliefs related to that factor. Therefore, it can be said that advanced/developed epistemological belief has a positive effect on attitude.

There is a negative correlation between the sub-dimensions of epistemological beliefs and the level of knowledge; relationship between of the belief that the learning depends on the effort and knowledge level (r = -0061, p = 0.085), relationship between of the belief that the learning depends on the ability and knowledge level (r = -0165, p = 0.000) and relationship between of the belief that there is only one truth and knowledge level (r = -0.067, p = 0.059). A similar effect is observed due to the situation mentioned above. So, it can be said that advanced/developed epistemological belief has a positive effect on knowledge levels. In addition, there is a significant positive relationship between attitude and knowledge level (r = 0.128, p = 0.000).

Table 4. The findings of preservice teachers' epistemological beliefs and attitudes /knowledge levels about OTD according to the gender

	Groups	**N**	**Mean**	**Standard deviation**	**df**	**t**	**p**
OTDAL (20≤x≤100)	Female	493	78.27	11.48	587	1.93	**.028**
	Male	96	75.73	13.25			
OTDKL (0≤x≤12)	Female	493	7.77	1.69	587	.015	.463
	Male	96	7.77	1.67			
BLDE (18≤x≤90)	Female	493	33.39	5.97	587	-.86	**.037**
	Male	96	33.98	7.09			
BLDA (8≤x≤40)	Female	493	17.81	4.46	587	-2.47	.568
	Male	96	19.06	4.81			
BTOT (9≤x≤45)	Female	493	26.22	4.85	587	-1.42	.237
	Male	96	27.01	5.26			

(**OTDAL:** Organ Transplantation and Donation Attitude Level, **OTDKL**: Organ Transplantation and Donation Knowledge Level, **BLDE:** The Belief that Learning Depends on Effort, **BLDA:** The Belief that Learning Depends on Ability, **BTOT:** The Belief that There is only One Truth)

Table 4 presents the results of the t-test, which indicates whether the preservice teachers' epistemological beliefs and attitudes and knowledge levels about organ transplantation and donation differ according to the gender variable. Kolmogorov Smirnov Test was used to determine whether the data showed normal distribution.

Table 5. The findings of the preservice teachers' epistemological beliefs and attitudes/ knowledge levels about OTD according to the grade level.

	Variants	**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
OTDAL (20≤x≤100)	Between Groups	1342.490	3	447.497	3.240	.022
	Within Groups	80792.644	585	138.107		
	Total	82135.134	588			
OTDKL (0≤x≤12)	Between Groups	60.150	3	20.050	7.210	.000
	Within Groups	1626.876	585	2.781		
	Total	1687.027	588			
BLDE (18≤x≤90)	Between Groups	36.938	3	12.313	.322	.809
	Within Groups	22358.291	585	38.219		
	Total	22395.229	588			
BLDA (8≤x≤40)	Between Groups	10.937	3	3.646	.176	.913
	Within Groups	12129.926	585	20.735		
	Total	12140.862	588			
BTOT (9≤x≤45)	Between Groups	355.122	3	118.374	4.976	.002
	Within Groups	13917.717	585	23.791		
	Total	14272.839	588			

(**OTDAL:** Organ Transplantation and Donation Attitude Level, **OTDKL**: Organ Transplantation and Donation Knowledge Level, **BLDE:** The Belief that Learning Depends on Effort, **BLDA:** The Belief that Learning Depends on Ability, **BTOT:** The Belief that There is only One Truth)

According to the results of the t-test in table 4, preservice teachers' attitudes about organ transplantation and donation shows a significant difference according to their gender (t (587) = 1.93, p = 0.028 <0.05). In other words, the mean scores of female preservice teachers' attitudes towards on organ transplantation and donation were higher than those of male preservice teachers. In addition, according to the findings in table 4, the hypothesis is accepted that preservice teachers' beliefs about learning depends on the effort shows a significant difference according to the gender of preservice teachers (t (587) =-0.86, p = 0.037 <0.05).

The high score obtained from each factor of the epistemological belief scale shows that the individual has immature or undeveloped beliefs related to that factor, while the low score indicates that the individual has matured or developed beliefs related to that factor. In other words, female preservice teachers' beliefs that learning is depends on effort is more developed than male preservice teachers' belief that learning is depends on effort. According to table 4, the level of knowledge of preservice teachers about organ transplantation and donation and the belief that learning depends on ability and that there is only one truth does not differ according to their gender. Table 5 shows the results of the one-way variance analysis, indicating whether the attitudes, knowledge levels and epistemological beliefs of the preservice teachers about OTD differ according to the grade level variable.

According to the results of the One-Way Analysis of Variance in table 5, the attitudes and knowledge levels of preservice teachers about organ transplantation and donation and their belief that there is only one truth show a significant difference according to the grade level. According to table 5, it was concluded that the preservice teachers' belief that learning depends on effort and ability did not show a significant difference according to the grade levels of preservice teachers. Levene test was used to determine whether the groups' variances were equal (Table 6).

Table 6. Test results for homogeneity of variables

Variables	Levene Statistic	df1	df2	p
BTOT	.504	3	585	.679
OTDAL	1.344	3	585	.259
OTDKL	4.246	3	585	.006

(**BTOT:** The Belief that There is only One Truth**, OTDAL:** Organ Transplantation and Donation Attitude Level, **OTDKL**: Organ Transplantation and Donation Knowledge Level)

According to the Levene test result in table 6, BTOT, OTDAL; since p>.05, variances were found to be equal and LSD test from Post Hoc Test was used in cases where the variances were distributed homogeneously. OTDKL; since p <.05, it was concluded that the variances were not equal and Dunnett's C Test was used from Post Hoc Tests in cases where the variances were not homogeneously distributed (Table 7).

Table 7. Post Hoc Test results for determining to the differences in terms of grade level

Post Hoc Tests	Variables	Grade Level (I)	Grade (J)	Mean Difference (I-J)	Std. Error
LSD	**OTDAL**	4th Grade	1st Grade	1.28820	1.25573
			2nd Grade	3.78745*	1.42829
			3rd Grade	3.15749	1.35794
LSD	**BTOT**	4th Grade	1st Grade	-1.94673*	.55340
			2nd Grade	-1.57258*	.56776
			3rd Grade	-1.60297*	.56340
Dunnett's C	**OTDKL**	4th Grade	1st Grade	.51310*	.19751
			2nd Grade	.77727*	.19700
			3rd Grade	.76106*	.20295

(**OTDAL:** Organ Transplantation and Donation Attitude Level, **BTOT:** The Belief that There is only One Truth**, OTDKL**: Organ Transplantation and Donation Knowledge Level)

According to table 7, the 4th grade students' attitudes towards OTD were found to be higher than the 2nd grade students. It was found that 4th grade students had more advanced epistemological beliefs (for BTOT) than the 1st, 2nd and 3rd grade students. The level of knowledge about OTD of 4th grade students was higher than the 1st, 2nd and 3rd grade students.

Table 8 shows the results of the one-way variance analysis, indicating whether the attitudes, knowledge levels and epistemological beliefs of the preservice teachers on organ transplantation and donation differ according to the department variable (preschool, classroom and science).

Table 8. The results of the one-way analysis of variance by indicating the attitudes, knowledge levels and epistemological beliefs of the preservice teachers in terms department variable

	Variants	Sum of Squares	df	Mean Square	F	p
OTDAL (20≤x≤100)	Between Groups	1084.086	2	542.043	3.919	.020
	Within Groups	81051.048	586	138.312		
	Total	82135.134	588			
OTDKL (0≤x≤12)	Between Groups	73.614	2	36.807	13.368	.000
	Within Groups	1613.413	586	2.753		
	Total	1687.027	588			
BLDE (18≤x≤90)	Between Groups	166.477	2	83.238	2.194	.112
	Within Groups	22228.752	586	37.933		
	Total	22395.229	588			
BLDA (8≤x≤40)	Between Groups	19.404	2	9.702	.469	.626
	Within Groups	12121.459	586	20.685		
	Total	12140.862	588			
BTOT (9≤x≤45)	Between Groups	698.504	2	349.252	15.077	.000
	Within Groups	13574.334	586	23.164		
	Total	14272.839	588			

According to table 8, it was concluded that the preservice teachers' belief that there is only one truth (BTOT), attitudes and knowledge levels were showed a significant difference according to department type of preservice teachers. Levene test was used to determine whether the groups' variances were equal in order to determine which groups differed according to the class level (Table 9).

Table 9. Test results for homogeneity of variables

Variables	Levene Statistic	df1	df2	p
OTDAL	1.020	2	586	.361
OTDKL	6.368	2	586	.002
BTOT	0.445	2	586	.641

(**OTDAL:** Organ Transplantation and Donation Attitude Level, **OTDKL**: Organ Transplantation and Donation Knowledge Level, **BTOT:** The Belief that There is only One Truth)

According to the Levene test results in table 9, since OTDAL and BTOT were p> 0.05, it was concluded that the variances were equal and LSD test from Post Hoc Test was used in cases where the variances were distributed homogeneously. According to table 9, since OTDKL were p<0.05, it was concluded that the variances were not homogeneously distributed. So it was used Dunnett's C Test.

Table 10. Post Hoc tests results for determining which differences between department variables of preservice teachers

Post Hoc Tests	Variables	Department Type (I)	Department (J)	Mean Difference (I-J)	Std. Error
LSD	**OTDAL**	Preschool Education	Science Education	2.08536	1.28197
			Classroom Education	3.30840*	1.18212
LSD	**BTOT**	Preschool Education	Science Education	2.87092*	.52463
			Classroom Education	1.29908*	.48377
Dunnett's C	**OTDKL**	Science Education	Classroom Education	.83370*	.17389
			Pre-School Education	.36060	.18346
Dunnett's C	**OTDKL**	Preschool Education	Science Education	-.36060	.18346
			Classroom Education	.47310*	.15492

(**OTDAL:** Organ Transplantation and Donation Attitude Level, **BTOT:** The Belief that There is only One Truth**, OTDKL**: Organ Transplantation and Donation Knowledge Level)

According to table 10, preservice preschool teachers' attitudes about OTD were higher than those of preservice teachers attending classroom teaching departments. In the belief dimension that there is only one truth, the epistemological beliefs of preservice preschool teachers were found to be more advanced than the preservice teachers studying in science and classroom teaching departments. In addition, preservice science teachers' knowledge about OTD were higher than of preservice classroom teachers; the level of knowledge of preservice preschool teachers on organ transplantation and donation was found to be higher than that of preservice classroom teachers.

Conclusion and Discussion

Our data analysis results obtained from preservice teachers indicated the high level of knowledge and positive attitudes regarding the OTD and matured/developed beliefs related to epistemological belief factors. In addition, the results of correlation matrix for relationship between attitude/knowledge and epistemological beliefs presents that advanced/developed epistemological belief has a positive effect on attitude and knowledge levels. Also, the results showed that there is a low positive relationship between attitude and knowledge level of preservice teachers.

The preschool, classroom and science teachers are an influential population group that plays an important role in introducing the children/adolescent groups to OTD by providing them with training and knowledge about the subject. However, not many studies have concentrated on all of this group of teachers. In the literature, few studies have been found assessing the attitude of secondary school teachers (Febrero et al., 2014; Lopez-Navidad, et al., 1999; Rios et al., 2010) and both primary and secondary teachers (Khoddami-Vishteh et al., 2011; Mohammadpour et al., 2018) toward organ donation. In addition, only one study has been investigated knowledge of the brain-death concept among secondary school teachers (Rios et al., 2012). In Spain, the results of the study by Febrero et al. (2014) showed that 75% of teachers support the organ donation, and their attitude was influenced by the psychosocial factors. In Lopez-Navidad et al. (1999)'s research have reported on this matter and only 20 teachers were interviewed, all of whom were sensitive to the issue of OTD, demonstrating a good knowledge of the general concepts related to OTD. Khoddami-Vishteh et al. (2011) carried out a study of 93 secondary school teachers in Iran finding 70% of teachers to be in favor of donating their organs. Khoddami-Vishteh et al. (2011) have reported the following as main factors affecting the attitude of teachers: knowing patients with serious diseases or transplant patients; the knowledge of the Brain Death concept; attitude toward blood donation; confidence in the healthcare system; and information about OTD in general. Rios et al. (2012) showed that a third of secondary school education teaching staff did not know or understand the brain death concept as the death of an individual. The knowledge of brain death positively affects attitude toward organ donation. Mohammadpour et al. (2018) studied to determine the awareness, attitude and performance of teachers toward organ donation. The results of this data analysis indicated the moderate level of awareness, positive attitudes and a relatively weak performance of teachers regarding the organ donation. Based on the results of the present study, the teachers had a favourable attitude towards the organ donation, but did not have a good performance in this regard.

Compared to studies above mentioned, the results of our study are similar in terms of positive attitude and high level of knowledge. A positive attitude and the highest knowledge about organ donation are expected from teachers because they are supposed to be role models. It is also very promising to obtain these results from preservice teachers. When examining the attitude and knowledge level concerning OTD in literature, it is seen that these studies were performed mostly with the medical students, high school students, middle school students and relatives of the patient (Lisowska, Budzinska, Scieranka, Mazur, Smolen, 2017; Ozturk-Emiral, et al., 2017; Saleem et al., 2009; Shi & Salmon, 2018; Weiss, Schober, Abati, Immer, & Shaw, 2017; Zampieron, Corso, & Frigo, 2010). In these studies findings show that to be an organ donor is affected by multiple factors; the knowledge level, socio-economic and socio-cultural status, awareness, religious beliefs, legal and medical processes. And also, although participants state that they want to donate their organs, the number of individuals carrying the organ donor card is very small. In this context these studies suggested that issues related to organ transplantation and donation should be included early in the training programs to improve the attitudes of students to organ donation and a more intensive interdisciplinary approach could bring about an even more positive attitude towards organ donation. In our study, knowledge and attitude had a significant positive correlation. In Chakradhar et al. (2016)'s research have reported on this matter and they illustrated knowledge, attitude and practice had a significant positive correlation with each other.

Also, in this research cross-sectional survey study assessed knowledge, attitude regarding OTD and epistemological beliefs among preservice preschool, classroom and science teachers according to different variables (gender, department type and grade level). In this population sample of teacher education at various branches, we found that knowledge levels about OTD significantly differ with grade level and department type. This difference for grade level is in favor of 4th grade preservice teachers. It can be said that 4th grade preservice teachers have higher knowledge levels about the OTD concept than the 1st, 2nd and 3rd grade preservice teachers. This difference for department type is in favor of preservice science and preschool teachers.

It can be said that preservice science teachers have higher knowledge levels about the OTD concept than preservice classroom teachers. In addition, preservice preschool teachers have higher knowledge levels about the OTD concept than preservice classroom teachers. The most important reason of this difference in the OTDKL in favor of preservice science teacher can be considered as the effect of undergraduate course contents. Science undergraduate courses such as biology, anatomy, physiology and health knowledge have a positive effect knowledge level. However, while the attitude varies according to the department variable, it has been observed that the course contents have no effect on this difference. According to this result, it can be said that while the level of knowledge on such socio-scientific subjects is directly related to the contents of the courses, attitudes are not directly affected by the knowledge.

Similarly, we found that attitudes regarding OTD affected with grade level, department type and gender. According to our results, the mean scores of female preservice teachers' attitudes towards on organ transplantation and donation were higher than those of male preservice teachers. The 4th grade preservice teachers' attitudes towards OTD were found to be higher than the 2nd grade students. And also, pre-service preschool teachers' attitudes about OTD were higher than those of preservice teachers attending classroom teaching departments. In addition, the results indicated that the epistemological beliefs (for especially BTOT dimension) affected with grade level and department type. It was found that 4th grade students had more advanced epistemological beliefs (for BTOT) than the 1st, 2nd and 3rd grade students. In the belief dimension that there is only one truth, the epistemological beliefs of preservice preschool teachers were found to be more advanced than the preservice teachers studying in science and classroom teaching departments. In addition, we found that female preservice teachers' beliefs that learning is depends on effort is more developed than male preservice teachers' belief that learning is depends on effort.

According to literature, Mohammadpour et al. (2018) showed that there were significant relationships among awareness, attitude and teachers performance about organ donation with age, teaching experience, education levels, teaching levels, disciplines of teaching and experience of participation in the course ($p < 0.05$), but there was no significant relationship with gender. In this study, the highest mean awareness, attitude, and performance scores were associated with the teachers who had the master's degree or higher education level. Obviously, the level of awareness and knowledge increase with the increase in the level of education. This finding is consistent with the results of our research including various grade level preservice teachers. Research suggests that the education level of health professionals is positively related to their personal willingness to donate organs (Schaeffner, Windisch, Friedel, Breitenfeldt, & Wolfgang, 2004). The positive effect of education level has been studied in various populations and may have a direct influence on attitudes toward organ donation (Ozdag, 2001; Ganta et al., 2018; Srivasta & Mani, 2018). The results of both us and other studies are very encouraging in terms of emphasizing the importance of education. Because, this shows that it will be possible to increase organ donation rates with the right training.

The results of this study showed that there was a significant difference between the male and female teachers in terms of their mean scores of attitude associated with organ donation ($p < 0.05$). This finding is consistent with the results of the study conducted by Febrero et al. (2014), who examined the attitude of secondary school working in the Southeast of Spain towards the solid organ donation and transplantation. These researchers show that seventy-six percent of female teachers support organ donation while seventy-three percent of the male teachers support organ donation. However, our results were not consistent with the study of Mohammadpour et al. (2018), who assessed the awareness, attitude and performance of teachers with regard to organ donation. The results of this study showed that there was no significant difference between the male and female teachers in terms of their mean scores of awareness, attitude and performance associated with organ donation.

In conclusion, our results have shown that gender, department type and grade level have played important roles in the positive attitudes for organ donation. To increase organ donation rates, it is impossible to change the economic status, religion, sex, age, and graduated schools. However, it is possible to give correct information about myths regarding organ donation. Except teachers, the sources of information for students are media, health workers, and religious figures. These sources could be used for education of organ donation. It is accepted that effective integration of issues about organ donation into the curriculum can be achieved by teachers who have positive attitude and high knowledge level on issues such as OTD.

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Author Information

Gulsah Gurkan [1]
Ministry of Education,
Kahramanmaras, Turkey

Sibel Kahraman [2]
Inonu University
Science Education, Malatya, Turkey
Contact e-mail: *sibel.kahraman@inonu.edu.tr*

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Conceptual Change Inquiry Curriculum and Traditional Lecture Approach: Preservice Teacher's Perceptions of Learning

Lloyd Mataka, Rex Taibu

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Abstract

A quasi-experimental treatment control group design was used to investigate the effect of a conceptual change curriculum, Multi-Step Inquiry approach, on students' perception of their learning in a science classroom. This started with the development of a workbook that explicitly focused on conceptual understanding, followed by the development and validation of an inventory to explore students' perceptions of learning. Interpretation of data involved the use of inferential and descriptive statistics. The inferential statistics included *t*-tests, ANOVA, Pearson correlations, and regressions. Cohen's *d* effect sizes facilitated further interpretation of the data. The analysis shows potential for the Multi-Step Inquiry to improve students' perceptions. These results provided room for recommendations for both research and teaching.

Introduction

The Next Generation Science Standards (NGSS) has proposed that American science education must put little focus on rote memorization while encouraging understanding and application as opposed to memorization of facts devoid of context (NGSS, 2013). According to NGSS, it is not just the content that matters, but how that content is obtained and applied. This is possible when students have sufficient opportunities to interact with the content in a meaningful way. One way to ensure that students have opportunities to effectively interact with learning materials is by teaching through inquiry. According to the National Research Council (NRC-Olson & Loucks-Horsley, 2000), in an inquiry class, students have opportunities to respond to scientific questions, obtain evidence through investigations, and explain and defend their explanations. In all this, the students are building up their communication skills. Therefore, inquiry teaching is a convincing tool to better fulfill the goals of the NGSS because students obtain knowledge while also making connections between the disciplinary core ideas, and the scientific and engineering practices.

Elementary teachers have a vital role of ensuring the effective implementation of the NGSS. As such, science educators entrusted with training these teachers need to find innovative ways to prepare the teachers for their job. This starts with providing modeling of effective instruction in the science classes for the pre-service teachers (PSTs). PSTs who experience effective inquiry instruction are likely to continue this with their students. In this study, we developed an inquiry approach termed Multi-Step Inquiry (MSI), specifically for conceptual change. The Multi-Step inquiry has the following features: (1) explicit discussion of misconceptions, (2) development of an investigation to address the misconceptions, (3) experimentations, (4) discussion of the concepts for the second time, and (5) writing misconception focused essays. This paper, therefore, is the evaluation of the effectiveness of this approach on improving pre-service teachers' perception of learning of science.

Conceptual Change

Marton and Säljö (1976) describe learning as either surface or deep. In surface learning, the focus is on rote memorization and there is a lack of connections among learned content, while in deep learning, the focus is on critically examining information and making necessary connections among content parts (Houghton, 2004). Haitte (2012) asserts that though rote memorization can be the foundation for some content, teachers must strive to get their students a deeper understanding of the content. Further, Lombard (2018) acknowledged the interdependence between effective learning and active learning. In this case, students must actively gain knowledge through answering deep questions, conducting meaningful hands-on activities, and reflecting on the meaning of these activities. Following are the behaviors that are prevalent in active learning.

1. Learning involves the active construction of meaning by the learner.
2. Learning facts ("what"– declarative knowledge) and learning to do something ("how"–procedural knowledge) are two different processes.
3. Individuals are likely to learn more when they learn with others than when they learn alone.
4. Meaningful learning is facilitated by articulating explanations, whether to oneself, peers, or teachers. (Michael, 2006).

According to Hewson (1992), conceptual change can mean that a learner has changed his or her mind or the material has made more sense to that learner. This is only possible when the student actively interacts with the learning materials. Conceptual change involves exchanging an existing idea with a new scientifically acceptable idea. This will be impossible if the student does not believe in this new idea. Posner and colleagues describe three important processes that may lead to an effective conceptual change:

1. there must be dissatisfaction with existing conception,
2. the new conception must be intelligible, and
3. the new concept must appear initially plausible (Posner, Strike, Hewson, & Gertzog, 1982).

As a result of the steps proposed by Posner et al. (1982), students are better confronted with information that can challenge their existing ideas only by actively participating in the learning process. Rote learning, whose hallmark is a teacher telling a passively listening student to memorize information, can become less believable in the mind of that student. Instead of students saying, 'our teacher said so', they should say, 'we understand it that way.' Therefore, it is crucial that students have a better perception of their learning in a conceptual change curriculum. For example, Ramaila and Ramnarain (2014) asked students about their perceptions of various types of learning indicating deeper and surface approaches. The deeper approaches included, "intention to understand oneself, relating ideas (constructive learning), and use of evidence" while the surface approaches include "memorizing without understanding, unreflective studying and fragmented knowledge, and unthinking acceptance" (p. 444). Students had higher scores for the deeper approaches than the surface learning approaches.

Koon and Murray (1995) assert that indicators of learning are not restricted to conceptual understanding but also to students' perceptions of the learning itself. Important indicators of students' perceptions include their perception of improved critical thinking, and interpersonal and intrapersonal capabilities among others (Koon & Murray, 1995). Research has shown that students' perceptions usually positively correlate with other learning outcomes in both cognitive and affective domains (Fraser, 2015). As a result, improving students' perceptions of their learning may also improve these other learning outcomes. This calls for teachers to develop curriculums that will enhance students' perception of their learning and the learning process.

Studies about Students' Perception

Improving learning outcomes is the major goal of education. One way this can be done is by ensuring that students have a positive perception of their learning. There has been ongoing research that has investigated the association between students' perceptions and other learning outcomes. Studies have shown relationships between students' perceptions and classroom performance (Ahmed, Taha, Al-Neel, & Gaffar, 2018; Odutuyi, 2012). Odutuyi (2012) found that the students' perceptions of the nature of teacher-student interaction patterns in high school chemistry were positively associated with classroom performance. The same study also showed that there was a significant positive association between students' perceptions and attitudes toward chemistry. Ahmed et al. (2018) similarly found a positive association between students' perceptions and academic performance in a cross-section of high school grades. Ahmed et al. (2018) proposed intrinsic elements found in positive students' perceptions, such as motivation and better study habits, as the factors that affected performance. Lizzio, Wilson, and Simons (2002) stated these sentiments earlier through their study, which found that students with more positive perceptions had deeper approaches to studying than those with negative perceptions of their learning environment. Further, An, Hannum, and Sargent (2007) found that students perception of classroom engagements had a positive significant correlation with engagement and performance.

They further found that students who had positive perception of their classroom engagement had less disciplinary problems.

Researchers have worked to improve students' perception of their learning. For example, Majerich and Schmuckler (2007) compared an active inquiry using demonstrations to traditional lecture with fewer demonstrations. These authors found that students had better perceptions of the inquiry than the traditional lecture class. Further, Rahman, Sarkar, Gomes, and Mojumder (2010) found that students liked cooperative and collaborative learning environments because these environments "provide students more opportunity to work deeply, increase the quality of work because the task can be distributed according to individual's skill, and make students co-construct their ideas, hence a clarity in understanding is possible" (p. 39). Duran, McArthur, and Van Hook (2004) investigated the impact of an inquiry college physics class on students' perceptions and found significantly more positive perceptions than those in the traditional lecture class. Another study by Hoskins and Gottesman (2018) used "CREATE (Consider, Read, Elucidate hypotheses, Analyze and interpret the data, Think of the next Experiment)" (p. 1) instructional approach to improve students' perceptions of a biology course. There was a significant shift from novice-like views to expert-like views within a semester of using CREATE. Similarly, Kazempour, Amirshokoohi, and Harwood (2012) instituted an inquiry in an undergraduate biology course, which enhanced students' perceptions. For instance, students indicated that they had a better understanding of the scientific process and the inquiry part improved their skills in collaboration work. These results agree with those by Lee and Kim (2018) who found that students had a better perception of learner-centeredness in a flipped inquiry classroom, characterized by academic debates, and observed significant changes in perceptions of both higher and lower-performing students. Further, Treesuwan and Tanitterapan (2016) found that students felt that learner-centered approaches encouraged interactions among students and improved their confidence in discussing their understanding with peers. In this study, we developed a Multi-Step Inquiry approach to improve learning outcomes such as students' perceptions of their learning of science. We, therefore, investigated the impact of the Multi-Step Inquiry on students' perceptions of learning in a science classroom. We further investigated the relationship between students' perceptions and conceptual understanding. We answered the following research questions:

- What is the impact of the MSI on students' perceptions of learning in a science classroom?
- What is the influence of perceptions and prior knowledge on students' conceptual understanding?

Method

The Intervention

For an intervention, we used an instructional module that focused on dealing with misconceptions. In this module, the misconceptions were discussed at the beginning and the end of the lesson. In between these discussions, inquiry activities were conducted to address these misconceptions. The inquiry activities involved developing investigations to address the misconceptions and carrying out these activities. The instructional module covered three physical science topics: (1) forces and motion, (2) heat and temperature, and (3) electricity. To cement conceptual understanding, students were given a list of misconceptions and asked to research and write about these misconceptions. A complete description of the MSI can be found in (Mataka & Taibu, 2020).

In the control group, the instructors taught using power point, experimentation, and group discussions. However, there was little emphasis on specific concepts in these group discussions. To elicit students' understanding of specific concepts, the instructor proceeded by emphasizing whole-class discussions. Unlike in the treatment group, the control group did not use the misconceptions instruction module. Nevertheless, the contact time between the two groups was almost similar. We will use the introduction of free fall as an example. Students were given several questions that elicited misconceptions about free fall. These questions were discussed in groups and each group came up with responses to these questions. Then the students were asked to plan an experiment that would help them answer some of the questions. The teacher guided the planning process. In the end, the teacher provided the students will balls of different masses and asked them to plan how they could use those balls to investigate the concept of free fall. The students planned their experiment with assistance from the teacher. After carrying out the experiments, each group presented to class their findings and a class discussion ensued. Then the class watched a YouTube video on free fall, followed by a demonstration of free fall from the instructor using a vacuum tube. Later, the students worked on detailed questions in their groups to check their understanding. At the end of the unit, the students wrote an essay that included several questions on free fall as shown in table 1. The traditional approach in the control group involved power point presentations by the instructor, experimentations, and group discussions of lab activities and specific concepts after the presentation, and students writing individual assignments. Notable differences were that no conception essay assignments were available. Instead, students were assigned a homework activity. Further, students were not required to discuss ways to investigate their conceptions, and there were no individual group discussions of specific conceptual questions. Instead, the instructor sought understanding from the whole class through verbal questions and from individuals using a short in-class assignment. Further, this section did not use the prepared misconception module. An effort was made to ensure an equal amount of contact time for both groups. Table 2 distinguishes the two instructional approaches for the two groups. These two approaches are described in table 1. The first author taught both treatment and control classes in Fall 2017, Spring and Fall 2018, and Spring 2019.

Table 1. Instructional approaches between experimental and control classes

Activities	Control	MSI
Preview discussions	• Whole class check of general previous knowledge through instructor oral questioning. • The questions focus on science misconceptions. • Teacher gets answers from different students. • Teacher introduces the day's activities	• Individual group discussions of written conceptual questions. • Group presentation of their conception to the whole class • In these presentations, students provide reasons for their answers. • Groups are asked to propose investigations that can help answer the conceptual question under consideration.
Experimental activities	• Students get involved in activities including experiments, demonstrations, or YouTube videos.	• Students are engaged in experiments, demonstrations, or YouTube videos specifically tailored to addressing misconceptions.
Post activities	• Groups present their results and conclusions to the whole class • Class summarizes the findings • The teacher verbally asks questions related to important concepts from the experiment to individuals in the class. • Teacher presents a PowerPoint addressing important concepts of the lesson. • Students write a short in-class assignment that addresses the class activity and check their changes in conception.	• Groups present their results and conclusions to the whole class • Class summarizes the findings • Another group discussion, revisiting the previous conceptual questions • Groups reflect on any changes to their earlier conceptions as they discuss. • Individual group discussion of added conceptual questions with teacher guidance • Whole class discussion of conceptual questions.
Essay	• A written individual homework assignment	• Conceptual essay

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The Instrument

We developed an instrument called "Perceptions of Learning" (See Appendix) based on the literature review that describes what skills and knowledge students must learn (Houghton, 2004; Lombard, 2018; Majerich &

Schmuckler, 2007). We also looked at other evaluation surveys like those created by the Foundation for Critical Thinking (https://www.criticalthinking.org/). The 'Perceptions of Learning' items were intended to measure students' views about learning in the physical science for PSTs class. When developing the instrument, the authors thought about what an effective classroom would look like. An effective classroom is where a student is able to understand the material being taught and teachers encourage the students to demonstrate this understanding. According to Houghton (2004), an effective classroom must have "clear goals and intellectual challenge; independence, control and active engagement; and learning from students" (p. 6). Baker, Miller, and Timmer (2018) also put appropriate student engagement as part of an effective classroom. Therefore, an effective classroom is where students can demonstrate understanding by answering open-ended questions, being given a chance to teach their colleagues, being able to provide reasons for their responses. Students can be engaged with the material individually or with colleagues. In an effective classroom, the students must feel that they have opportunities to learn on their own but also collaboratively (Michael, 2006). Therefore, the instrument has questions related to students' engagement. Further, Stern and Algren (2002) proposed that science curriculum assessments must focus on students' understanding and how the instructional activities address the goals of the class. Students must feel confident about their understanding of the material. Therefore, this instrument has questions that focus on students' views of their understanding and application. In addition, Barr (2016) asserts that an effective learning environment encourages involvement, satisfaction, and individualization. This implies that students must actively participate in instructional activities while enjoying the class and being independent. As a result, the instrument has focused on students' perceptions of their conceptual understanding, ability to apply, ability to work collaboratively, and the suitability of the materials for the course. All these activities align with a theory proposed by Kearsley and Shneiderman (1998), Engagement Theory, which defines engaged learning where "student activities involve active cognition processes such as creating, problem-solving, reasoning, decision making, and evaluation" (p. 20). Engagement theory further encourages instruction that provides meaning to the material being learned. These are issues being addressed by the instrument.

One of the researchers developed the instrument and sent it to the co-researcher to make suggestions. The instrument was then later sent to two science educators for face validity. Then we used the instrument to collect data from 72 participants in Fall 2017, Spring and Fall 2018, and Spring 2019 semesters. All the Institutional Review Board (IRB) processes were addressed. After collecting the data, we investigated how variables within the instrument related to the constructs that we sought using confirmatory factor analysis. The analysis came up with three factors that we named, (1) Individual Learning and Application (ILA), (2) Higher-Order Learning (HOL), and (3) Views on Group Engagement (VGE). We used varimax rotation for loading because we wanted to maximize the variance of the loadings and also its popularity (Abdi, 2003). Using the Varimax rotation, nine items out of eighteen loaded on factor 1, five items loaded on factor 2, and four items loaded on factor 3. Table 2 shows the factor loadings.

Table 2. Factor analysis

Item #	ILA	HOL	VGE
1	0.734		
2	0.714		
3	0.576		
4	0.691		
5		0.684	
6			0.664
7			0.714
8		0.746	
9		0.768	
10		0.722	
11			0.540
12	0.723		
13	0.650		
14			0.751
15	0.643		
16	0.663		
17	0.700		
18		0.590	
Alpha	0.90	0.87	0.80

We also tested the reliability of the instrument and found a Cronbach's α of 0.93. Further tests of each factor resulted in the alpha value of 0.90 for factor 1, 0.87 for factor 2, and 0.80 for factor 3, all of which are acceptable. We further tested the items using a split-half correlation with Spearman-Brown Correction. The correlation coefficient between even and odd items was 0.90. After the Spearman-Brown correction, the correlation coefficient changed to 0.95, which is high. This shows that the instrument strongly measures what it is intended for. We collected data on student conceptual understanding (pre and post) using a concept inventory developed by the Mataka and Taibu (2020)

Participants

We used convenience sampling for our research because data were collected from students who attended a physical science class for pre-service teachers. Seventy-two pre-service elementary teachers from a Northwestern USA college participated in the study. Over 90 percent of the participants were female. These participants enrolled in a physical science class for pre-service elementary teachers at this college during Fall 2017 (N = 22), Spring 2018 (N = 16), and Fall 2018 (N = 20) and Spring 2019 (N = 14) semesters. As a result, the sample was convenient. The control group came from Fall 2017 and Spring 2019, while the treatment group came from Spring and Fall 2018. The participants had very little background in college science but were introduced to physical science in middle and high school. Of these participants, 36 were in the experimental group and 36 were in the control group. We sought human subject review board approval to ensure adherence to proper research ethics.

Data Analysis

We analyzed the data using Minitab. Data analysis involved the use of both descriptive and inferential statistics. Kolmogorov-Smirnov test was used to establish the normality of the data while Levene's test established equality of variances. Pearson correlation was used to show relationships among different variables, while multiple regressions were used to show the influence of predictors.

Results and Discussion

Comparison of Perceptions between Experimental and Treatment Groups

To fulfill the requirements of parametric tests, we used Kolmorov-Sminorv (KS) tests to check for normality of data. The KS value was 0.08 (p = 0.63), indicating a normal distribution, and consequently justified the use of parametric analysis. We then used Levene's test to determine score variances for the experimental and control groups. Based on this test, the two groups had equal variances (p = 0.21). Therefore, the two groups were compared using independent t-tests assuming equal variances. Table 3 presents the mean scores, the p-value, and Cohen's d. Note that the total score for a given completed survey was computed by adding up the Likert scale numbers circled by a particular student. Based on the t-test, the experimental group had significantly higher perceptions mean score than the control group (t = 2.95; p = 0.004). A large Cohen's d (d = 0.70) shows that this difference also had practical significance.

Table 3. Control and treatment groups' mean Perception of Learning scores

Group	N	Mean (out of 90)	SD	t	p	d
Experimental	36	71.14	9.28	2.95	0.004	0.70
Comparison	36	63.50	12.44			

As stated earlier, the analysis of the Perceptions of Learning instrument resulted in three factors: ILA, HOL, and VGE. Table 4 presents the mean scores of each of the three categories for the treatment and control groups. We tested to determine if there were any differences in the way students responded to each of the three categories using one-way ANOVA. Results indicate that there was no significant difference among the three mean scores for the control group (F = 3.08, p > 0.05). A significant difference was observed for the treatment group (F = 4.04, p < 0.05). A Bonferroni posthoc test indicated that experimental group students had significantly higher perceptions about group engagement (VGE) than individual learning and application (ILA), and higher-order learning attributes (HOL).

Using the same table, we conducted an analysis to determine if there is a difference between the treatment and the control groups in each of the three categories. The treatment group had higher perceptions in all three categories than the control group. The *t*-test showed that these differences were significant in all three categories.

Table 4. Comparisons based on test categories (Mean scores are out of 5)

	Control	Treatment	*t*-test *p*-value
ILA	3.44 ± 0.71	3.87 ± 0.56	< 0.05
HOL	3.43 ± 0.88	3.89 ± 0.60	< 0.05
VGE	3.84 ± 0.77	4.22 ± 0.61	< 0.05
ANOVA *p*-value	> 0.05	< 0.05	

Relationships among prior Knowledge, Students' Perceptions, and Conceptual Understanding

It is important to understand the implication of higher perceptions toward other important outcomes in a science classroom. As such, we carried out an investigation to determine if there is a relationship between perceptions and conceptual understanding. In this case, we collected pre- and post-tests to measure conceptual understanding. Then we used Pearson correlations to investigate the following relationships: prior knowledge (pre-test) and the posttest, perceptions and the post-test, prior knowledge and the conceptual change, and perceptions and the conceptual change. The conceptual change score is a result of the subtraction of the pretest score from the posttest score. Table 5 shows the results of multiple correlations. The results show there was a significant positive relationship ($r = 0.35$) between prior knowledge and the post-test performance. However, there was a nonsignificant negative relationship ($r = -0.23$) between prior knowledge and conceptual change. The results further showed a positive and significant ($r = 0.36$) relationship between perceptions and the post-test. This indicates that students with higher perceptions of their learning had higher post-test and conceptual change scores.

Table 5. Pearson correlations

	Pretest	Perceptions	Post-test	Conceptual change
Pretest	1			
Perceptions	-0.001	1		
Posttest	0.35**	0.35**	1	
Conceptual change	-0.23	0.36**	0.83**	1

**The relationship is significant

The Predictive Influence of Perceptions' and Prior Knowledge's on Conceptual Understanding

We investigated relationships between the two predictors; perceptions and prior knowledge, to the posttest score, and the same predictors to the conceptual change using regression analysis. In both cases, perceptions and prior knowledge are our independent variables while the post-test and conceptual change are our dependent variables. Table 6 shows the results of the regression model. The adjusted R-squared ($R^2 = 0.22$) indicates that the model explains 22% of the variance in posttest performance. This means that the combined effect of prior knowledge (pretest) and students' perceptions accounted for 22% of the variances in posttest performance. The beta coefficient for perceptions ($\beta = 0.43$, $p < 0.05$) shows that for every unit increase in students' perceptions, posttest performance increases by 0.43 points. Further, the beta coefficient for prior knowledge ($\beta = 0.61$, $p < 0.05$) shows that for every unit increase in prior knowledge, the posttest performance increases by 0.61 units. The results show that perceptions have a significant positive association with post-test performance when the prior knowledge (pretest score) is held constant. A similar, association is observed between prior knowledge (pretest score) and the post-test performance when perceptions scores are held constant.

Table 6. Posttest scores using predictors perceptions and prior knowledge

Term	Coefficient	SE Coeff	t-value	P-value	Adj R-sq
Constant	6.47	3.38	1.91	0.060	0.22
Perceptions	0.43	0.13	3.30	0.002	
Prior Knowledge	0.61	0.18	3.37	0.001	

Table 7 shows the results of a regression model for conceptual change when perceptions and prior knowledge are predictors. The adjusted R-squared ($R^2 = 0.16$) indicates that the combined effects of perceptions and prior knowledge account for 16 percent of the variance in conceptual change. The beta coefficient for perceptions ($\beta = 0.43$, $p < 0.05$) shows that for every unit increase in students' perceptions, conceptual change increases by 0.43 units. In contrast, the beta coefficient for prior knowledge ($\beta = -0.38$, $p < 0.05$) shows that for every unit increase in prior knowledge, the posttest performance decreases by 0.38 units. The results thus show that perceptions have a significant positive association with conceptual change while prior knowledge has a significant negative association with the conceptual change.

Table 7. Conceptual change using predictors attitude and prior knowledge

Term	Coefficient	SE Coeff	t-value	P-value	Adj R-sq
Constant	6.47	3.38	1.91	0.060	0.16
Perceptions	0.43	0.13	3.30	0.002	
Pre	-0.39	0.18	-2.11	0.038	

Discussion

Looking at the results, a significant difference was observed between the treatment and control groups. Further, the observed large effect size ($d = 0.7$) indicates that this difference also has practical significance. This study has shown that students taught using MSI had a better perception of their learning in the science classroom than those taught using the traditional approach. This is likely because the MSI provided a challenging environment for the students and enabled them to take ownership of the learning process. The MSI involved activities that encourage meaningful conceptual change (Mataka & Taibu, 2020) by letting the students explore concepts, develop an investigation to address misconceptions, carry out the experiment, and revisit the concepts. Further, giving students a chance to discuss these concepts in the essay form solidifies their understanding. Therefore, this observed improvement is unsurprising. In addition, students in MSI were given opportunities to collaborate with colleagues in making sense of the activities. As observed by Rahman et al. (2010), collaborative and cooperative environments enable students to distribute work based on skills and thus enhance understanding. Results from this study align with others who found that various forms of inquiry improved students' perceptions (Hoskins & Gottesman, 2018; Kazempour, Amirshokoohi, & Harwood, 2012; Majerich & Schmuckler, 2007; McArthur & Van Hook, 2004). Further, Houghton (2004) stated that providing intellectual independence and letting students learn from each other can improve their perceptions. In the conceptual change curriculum used in this study, students were allowed to explore concepts individually through conceptual essays and individual class activities while also collaboratively working on classroom problems. This enabled students to become independent while also learning from each other. This observation can also be, as Barr (2016) stated, a result of students' satisfaction with their learning environment due to being given opportunities to work with the learning materials individually and collaboratively. Further, the activities in the conceptual change inquiry course provided students with deeper and meaningful learning. Ramaila and Ramnaria (2014) found that students had a higher perception of deeper learning than surface learning. This may add to the observed improvement in the conceptual change inquiry in this study. In addition, the instructional approach used in this study may have improved students' interactions and confidence in their own learning as observed by Treesuwan and Tanitterapan (2016).

Looking at the results of factor analysis, three factors were observed. The factor analysis provided a chance to compare students' perceptions based on these three different categories; ILA, HOL, and VGE. There was no significant difference among the three factors in the control group based on ANOVA. However, a significant difference was observed in the treatment group; specifically, students had better views of group engagement (VGE) than the individual learning (ILA) and higher-order learning attributes (HOL). This is expected because the MSI focused on group interactions as the students engaged in the activities. Unsurprisingly, the treatment group performed significantly better than the control group in all three categories.

Results of the correlation studies show that, indeed, perceptions have a positive significant relationship with both conceptual understanding and change in conceptual understanding. We also investigated the relationship between prior knowledge, conceptual understanding, and change in conceptual understanding. Although prior knowledge had a significant positive correlation with conceptual understanding, there was a nonsignificant negative correlation with conceptual change. Further, regression studies indicated that students' perceptions had a significant positive contribution to both conceptual understanding and conceptual change. Prior knowledge, however, had a significant positive contribution to conceptual understanding only. A significant negative contribution was observed between prior knowledge and conceptual change. This is unsurprising because students who already know the material will tend to have a smaller increase in knowledge than those who know less. It also means that students who performed poorly during the pretest were able to close the gap with their colleagues. These results also imply that students' perceptions are more important in predicting changes in conceptual understanding than prior knowledge. This is likely due to the enthusiasm to learn that comes with positive students' perceptions. Students with positive perceptions would likely put more effort into the learning process and are more likely to improve their conceptual understanding. This aligns with the conclusion by Ahmed et al. (2018) who suggested that intrinsic elements found in positive students' perceptions, such as motivation and better study habits, are the factors that affect performance. This is echoed by Lizzio, Wilson, and Simmons (2002) who found that students with more positive perceptions had deeper approaches to studying than those with negative perceptions of their learning environment. These results also show that providing students a favorable learning environment can result in improvement in their perception of learning regardless of prior knowledge.

Recommendations

This study enhances the need for innovating inquiry teaching approaches that can improve students' perceptions of their learning. The study has shown that MSI is one of those techniques that has been shown to enhance students' perceptions. Furthermore, the study has shown why it is crucial to improve students' perceptions. The contribution of perceptions to both conceptual understanding and conceptual change provides a way for teachers to find effective approaches that can enhance students' understanding. In addition, the instrument in this study can be used to obtain information about students' perceptions of their learning and thus help both science education researchers and teachers understand their students better.

Limitations

This research occurred through several semesters to ensure that a relatively larger sample was obtained. Researchers, thus, tried their best to ensure that students were given similar experiences based on whether they were in treatment or control groups.

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Author Information

Lloyd Mataka
Lewis-Clark State College
Lewiston ID, 83501, USA
Contact e-mail: *lmmataka@lcsc.edu*

Rex Taibu
Queensborough Community College–City University of New York, Bayside, New York 11364

Appendix

Name____ Date____________

Perceptions of Learning

Rate the activities on a **five-point** scale depending on how much they helped you as follows.

1 (Not much) -------- 5 (Very much)

No	Statement	Rating				
1	To what extent did the class activities improve your learning?	1	2	3	4	5
2	To what extent did the class activities make you change your understanding of science concepts?	1	2	3	4	5
3	To what extent can you apply the knowledge you have learned using activities in this class?	1	2	3	4	5
4	To what extent can you teach someone based on the activities in this class?	1	2	3	4	5
5	To what extent did the materials encourage independent learning?	1	2	3	4	5
6	To what extent did the activities encourage thinking?	1	2	3	4	5
7	To what extent did the activities enable you to communicate your understanding to your colleagues?	1	2	3	4	5
8	To what extent did the activities encourage questioning skills?	1	2	3	4	5
9	To what extent were the activities able to make you distinguish what you know from what you don't know?	1	2	3	4	5
10	To what extent did the activities encourage synthesis of information.	1	2	3	4	5
11	To what extent did the class activities encourage your engagement in class?	1	2	3	4	5
12	To what extent did the class activities provide opportunities for making sense of the science activities?	1	2	3	4	5
13	To what extent can you describe the materials as learner centered?	1	2	3	4	5
14	To what extent did the activities encourage collaborative (group) work?	1	2	3	4	5
15	How do you rate the effectiveness of activities in this class?	1	2	3	4	5
16	How appropriate are the activities for this class?	1	2	3	4	5
17	How likely are you to use some of these activities in your future endeavors?	1	2	3	4	5
18	How did the activities meet the goals of the class?	1	2	3	4	5